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Who Pays for a Strike?

IF IT were agreed
That the capitalist should be assured of the safe return of his investment and a fair rate of interest upon money actually invested for the time that it was in use;

That the one who furnishes the brains and inspiration and initiative to start and conduct a business and takes the risk of making it go should have a fair profit;

And that the men who do the work, all the way from the president to the office boy should receive salaries or wages commensurate with the services rendered;

Then it would be easy to compute the cost of a product or service and the price at which it should be sold to return a fair profit.

The payroll, being an item of that cost and selling price, the wage scale is a matter between the manufacturer and the user of his product, to whom he passes on any increase in the expense of production.

When, then, a group of workers become dissatisfied with their wages or condition, the question is not merely one between them and their paymaster but between them and the public.

And inasmuch as the workman is a very large part of the public and inasmuch as everything that he buys is the product of human labor, the question resolves itself ultimately into one between one group of labor and all the rest.

Any increase to one class diminishes the purchasing power of the day's work for all the rest.

The exorbitant demands of the building trades are met by everybody who pays rent or buys anything that is manufactured or sold in one of the buildings, the cost of which they have magnified.

If they all allowed each other to double their wages, things would cost twice as much and nobody would be any better off.

The time will come when a conspiracy to quit work simultaneously at a time when such quitting will occasion the greatest amount of public inconvenience and distress will be as unthinkable as any other high-handed method of obtaining a temporary advantage.

F. R. Low

Surface-Condenser Operation

By PAUL H. JEYNES

THREE factors in surface-condenser performance present opportunities for effecting economies and are therefore worthy of careful consideration. They are: (1) Amount of circulating water; (2) period between cleanings; (3) refrigeration or cooling of condensate.

Each of these three is affected by a large number of variables, some rather difficult of exact determination. The problem is to reduce test data to a form

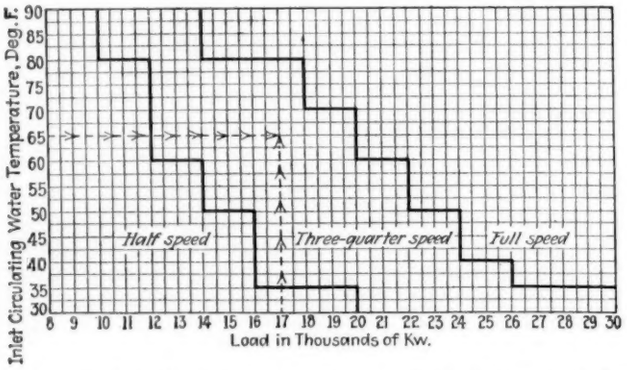


Fig. 1—Circulating-water pump speed determined by load and inlet water temperature

Example—For 17,000 kw. load with 65-deg. cooling water the pumps should operate at the three-quarter speed point.

easily used and understood by the operating force. Although this will involve neglecting several minor factors, the greatest care should be used in preparing such information in order to gain the confidence and co-operation of the men who will use it.

Regulation of Circulating Water

Most large installations are now provided with means for regulating the amount of circulating water in some degree by use of either duplicate pumps or variable-speed drives. A few simple tests will suffice to establish the most economical schedule for the operation of pumps at all loads and inlet-water temperatures. It is not to be expected that such a schedule can be rigidly enforced in all cases, but its adoption can be made to effect large savings without unduly complicating operation.

A suggested form for this schedule is illustrated in Fig. 1. Each combination of load and inlet temperature determines a point falling in the field marked "half-speed," "three-quarter speed" or "full speed," as the three possible rates are conveniently called in this instance.

A preliminary study of operating records will in many cases indicate certain load and temperature conditions for which beyond a doubt the maximum amount of circulating water is necessary, and certain light loads and low temperatures for which the minimum is sufficient. This will minimize the number of tests by confining them to the fairly narrow limits of these variables.

The tests consist simply in observing the improved vacuums corresponding to increased amounts of circulating water at various temperatures and loads in the doubtful range.

The schedule is determined by balancing the increased pumping cost against the saving in steam consumption of the main unit resulting from the improved vacuum. For steam-driven auxiliaries the data may be conveniently arranged as in Table I, the proper amount of circulating water being that which results in the least total water rate.

The improvement in main-unit water rate may be quickly computed by allowing 6 per cent per inch increase in vacuum, a good average value for large units at ordinary vacuums, thus necessitating an accurate determination of main unit steam consumption at only one load and vacuum.

The preliminary plotting of a curve similar to Fig. 2 will further simplify the collection of this information. This curve shows the improvement in vacuum which must be obtained in order to justify the use of increased amounts of cooling water at various loads. It is prepared by first assuming average water rates

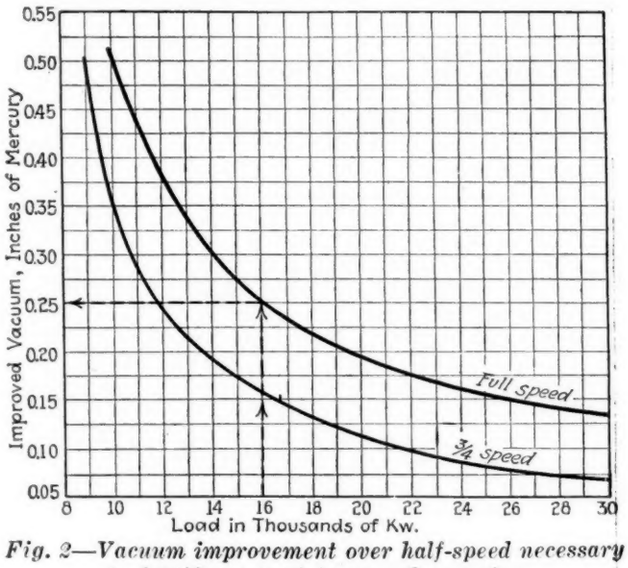


Fig. 2—Vacuum improvement over half-speed necessary to justify cost of increased pumping

Example—At 16,000 kw. with the pump going three-quarter speed, the vacuum must be raised 0.25 — 0.16 = 0.09 in. to make full pumping speed justified.

for several loads and computing the increased vacuum necessary to reduce the steam consumption at 6 per cent per inch sufficiently to pay the increased pumping

TABLE I—ARRANGEMENT OF DATA FOR BALANCING PUMPING COST

Load on Main Unit	Inlet Water Temperature	Corrected Vacuum	Water Rate Main Unit	Water Rate Pumps	Water Rate Total

charge. Of course such an average curve will not be accurate for all conditions, but it will facilitate the collection of data by indicating at a glance many tests not worthy of full computation.

The degree of dirtiness will have some effect on such a schedule, but this is one of the variables the effect of which is not ordinarily considerable enough to justify the complications attendant upon their inclusion.

Period Between Cleanings

Two methods of keeping a daily check on the cleanliness of condenser tubes have been advanced. There are two objections to the method that first suggests itself—a daily computation of the heat transfer coefficient from the familiar formula

$$K = \frac{\textit{lb. of cooling water per hr.} \times \textit{temp. rise}}{\textit{sq.ft. of heating surface} \times \textit{mean temp. difference}}$$

In the first place, a decreased value for K is not easily converted into a loss in dollars. In the second place, it cannot be calculated with any degree of accuracy from readings ordinarily obtainable.

The second method, employing curves showing the vacuums to be expected at all loads and temperatures with clean tubes, has proved very satisfactory in practice.[1] The difficulty encountered with this scheme is the determination of these curves, which must be very accurate to give consistent results.

As the data can be obtained only at times when the condenser is known to be clean, the task will become interminable unless short-cuts are applied. Unfortunately, the guarantee curves generally furnished by the manufacturer are so conservative as to be without

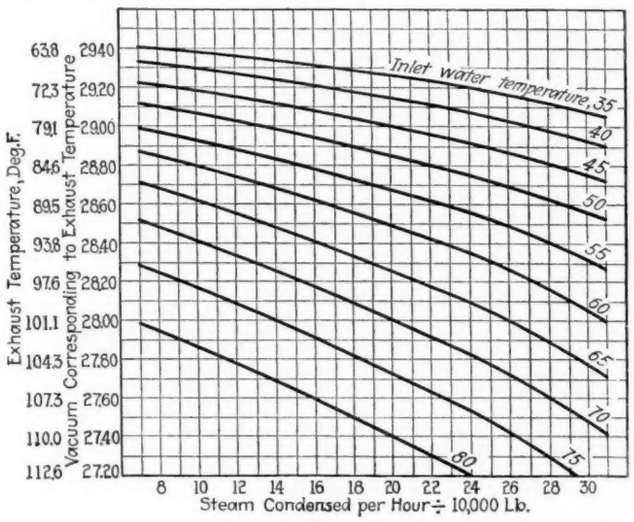


Fig. 3—Relation of water temperature to condenser performance for clean tubes

Condensing 200,000 lb. per hour with 70-deg. circulating water the temperature of the exhaust steam entering the condenser should (if the tubes are clean) be that corresponding to a 28-in. vacuum, or 101.15 deg. F., condensing the same weight of steam per hour with circulating water of 45 deg. this temperature should be that corresponding to a 29-in. vacuum or 79.1 deg. F. If the temperatures are materially higher than those of the diagram, it is an indication that the cooling surfaces are dirty.

value for this purpose. Constant revision is also necessary as the condenser ages.

Fig. 3 illustrates a satisfactory form for "clean condenser" curves. Points to be noted are:

1. Ordinates are vacuums corresponding to "exhaust temperatures to be expected"; that is, the criterion for condenser cleanliness is the temperature of the exhaust steam rather than the vacuum gage reading, since the latter is affected more directly by air leakage. If vacuum as shown by the gage were used, a partial air pressure of 0.3 in., which is not unusual, would make a really clean condenser appear to be very dirty. This

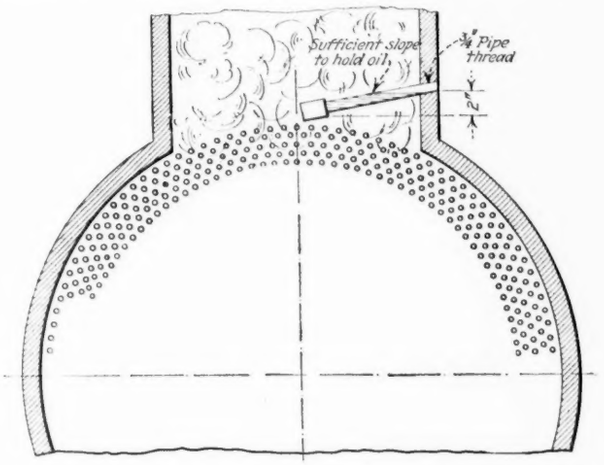


Fig. 4—Oil well for thermocouple in condenser exhaust-steam space

source of error is largely eliminated through reference to the exhaust temperature.

2. Abscissas are pounds of steam condensed per hour. If more convenient, the load in kilowatts may be used without appreciable error. Even though steam be bled from one or two stages, the amount abstracted is usually so constant at each load as to have little effect on the accuracy of the curves.

3. The effect of the amount of water used is neglected. If a schedule for circulating pumps is adopted as outlined in the first part of this article, the amount of water will be defined for each load and temperature and need not be considered in this connection.

In spite of comments by numerous observers on the difficulty of obtaining true values of the exhaust steam temperature, an ordinary mercury thermometer with a long stem extending into the steam space over the tubes will be found to give consistent results in most cases. If this location is inaccessible, an arrangement similar to Fig. 4 may be used to provide for a thermocouple at this point.

Accurate curves can be plotted from few observations if use is made of the straight-line law for condensers. A typical illustration is Fig. 5. Hundreds of observations on clean condensers have established the existence of this straight-line relation between inlet water and exhaust-steam temperature for condensers in which the exhaust steam is not superheated. Two points at different temperatures will determine the straight line corresponding to each load, and the derivation of the clean condenser curves from this information is simple and obvious. Each time the condenser is cleaned, readings should be obtained at as many loads as possible and plotted on straight-line curve sheets, thus permitting revision of the curves when necessary to meet new conditions arising from the removal or plugging of tubes, etc.

It is suggested that a set of readings be taken each day at a time when the load may be expected to remain

[1] Article by C. E. Colborn, *Power*, vol. 58, p. 803-5, 1923.

fairly constant, preferably at the same hour each day. Observations are taken of

1. Load or steam rate.
2. Inlet-water temperature.
3. Exhaust steam temperature.
4. Condensate temperature.
5. Vacuum.
6. Barometer.

A form for reporting daily conditions is illustrated in Table II.

TABLE II—DAILY CONDENSER REPORT

Station ..... Date..... Time.....

Unit No.	1	2	3	4
1. Partial air pressure.				
2. Barometer minus actual vacuum.				
3. Exhaust minus condensate temperature.				
4. Vacuum below clean condenser.				
5. Cost of steam loss since last cleaning.				
6. Remarks.				

Item 1 is computed by subtracting the vacuum as shown by the gage corrected to a standard barometer, from the vacuum corresponding to the exhaust temperature. This is a measure of the air leakage, and is generally less than 0.3 in. of mercury if the equipment is tight and the pumps in good condition.

Item 5 is a cumulative total carried forward each day, as is best illustrated by an example. Assume that a condenser on the first day after cleaning condenses 4,000,000 lb. of steam. Readings at the end of the day showed a vacuum below clean condenser of 0.05 in. Let L_1 = loss due to dirtiness the first day, L_2 = loss due to dirtiness the second day, and C = cost per pound of steam.

Then L_1 = steam condensed $\times$ average vacuum below clean condenser $\times$ 6 per cent $\times$ $C = 4{,}000{,}000 \times \frac{0.05}{2} \times 0.06 \times C$.

As explained previously, a good average value for decrease in water rate with improved vacuum is 6 per cent per inch (for large units at ordinary vacuums). Obviously, the increased steam consumption during the first day in per cent will equal ave. vac. below clean condenser $\times$ 6 per cent.

The increased steam consumption *in pounds* will be equal to ave. vac. below clean condenser $\times$ 6 per cent $\times$ total steam condensed during the day.

Strictly speaking, the last item should be the total steam that would have been condensed with clean condenser; or the actual steam divided by (1.00 + 0.06 $\times$ ave. vac. below clean condenser). The difference does not justify this calculation.

If the cost of steam per pound is C, the loss due to dirtiness (L) is $C \times$ increased steam consumption in pounds, or

$L = C \times$ ave. vac. below clean cond. $\times$ 0.06 $\times$ steam condensed.

Incidentally, it is important that the "average vacuum below clean condenser" be computed exactly as in the examples; that is, = "vacuum below clean condenser" at start plus half the increase in "vacuum below clean condenser" noted at the end of the day. This assumes that the dirtiness increases at a uniform rate during each individual day, though not necessarily over a period of days. Experience has shown the error in assuming a uniform rate over periods longer than one day.

The second day 6,000.000 lb. was condensed, and at the end of the day readings showed the vacuum to be 0.07 in. below clean condenser. Obviously, the steam was condensed that day at an average vacuum below clean condenser of $0.05 + \frac{0.02}{2} = 0.06$ inches.

Then $L_2 = 6{,}000{,}000 \times 0.06 \times 0.06 \times C$.

Item 5 for the second day is thus $L_1 + L_2$.

When this cumulative total equals the cost of cleaning, the condenser should be cleaned at the first opportunity for greatest economy. A check mark in column 6 is used to indicate this fact.

A graphical record of condenser conditions is of interest to the engineer, but for purposes of computation the method outlined will be undertaken with greater assurance by a clerical force and may be made a matter of daily routine.

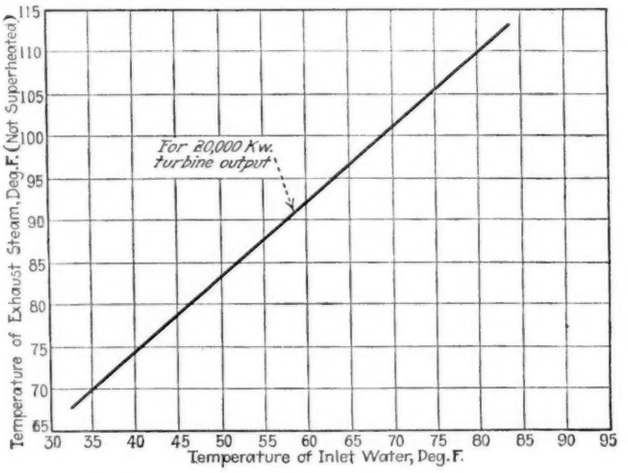


Fig. 5—Showing straight-line temperature relation for constant condenser load

Refrigeration of Condensate

Under the best conditions, unless special measures have been taken to obviate it, a slight depression of condensate temperature below that of the exhaust is to be expected, due to the unavoidable pressure drop through the condenser from throat to air-pump connection and the natural tendency of air to sink to the bottom, but a great many large units are in operation which show a hardly perceptible temperature difference. On the other hand, an actual depression of 30 deg. has been recorded with 35 deg. inlet water.

A persistent cooling of the condensate to more than two or three degrees below the exhaust may justify a consultation with the designers of the condenser. A collection of daily readings extending over the complete range of inlet temperatures will prove invaluable in such a study. The trouble may often be ended by relining, or a judicious selection of tubes for removal or plugging.

Air leakage will affect the condensate temperature. Air, being so much heavier than steam at low pressures, is liable to blanket the lower banks of tubes, effectually limiting the work done by this part of the condenser to a further cooling of whatever moisture drips on them from above. Any steam existing at that point as steam will be at a lower temperature due to its smaller partial pressure.

This condition may influence the circulating pump schedule at low temperatures. Any improvement in the

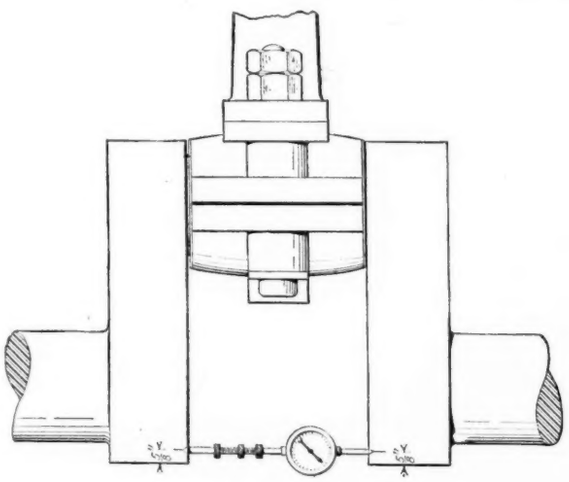
condensate temperature coincident with reducing the amount of circulating water should be expressed in dollars and combined with the saving in pumping costs. The gain due to warmer condensate may be estimated at 0.07 per cent per degree, though its actual value for any particular plant will of course depend on the method of heating the feed water.

In conclusion, the keeping of daily condenser records cannot be stressed too strongly. Not only may installed equipment be made to give maximum performance, but further additions to existing plant may profit from information concerning local conditions which could not be predicted without such data.

Checking Crankshaft Alignment

By John W. Cook

The care of the crankshaft is one important item which appears to be neglected in many Diesel plants. After an engine has been in operation for some time, there is a tendency for the journals to become eccentric.



Using micrometer on crankshaft

It is wise to test them at each annual overhaul for concentricity, and should they be found to be out of round, they must be trued up either by fling and lapping or turning in a lathe.

The shaft should be supported in all its bearings, and these bearings, including the outboard one, must be in perfect alignment. The easiest and most satisfactory manner to do this is by using a dial micrometer. This valuable instrument, although not employed as extensively as it should be, is accurate and reasonable in cost.

To check the shaft alignment, mark off the center lines of each crank web; then $\frac{5}{8}$ in. from the top of each web make a small center, being sure to remove all burrs, etc. Next place one crank a little beyond bottom center, sufficient to allow the micrometer to fit between the centers. Now adjust the micrometer, allowing about $\frac{1}{4}$-in. tension on the spring and measure the distance between the webs. Set the dial to read zero so that any future readings will show plus or minus. The shaft should be turned and the dial readings noted when the crank is at the bottom and top centers, as well as when at the front and back quarters. Each crank should be similarly measured and the results tabulated. Should the difference in the dial reading of any one crank when at top and bottom centers be greater than about 0.003 in., the bearings need attention.

If a bearing is high, the crank webs will open out when the crank is put on top center and close in when it is placed on bottom center. Should an outboard bearing be high, it naturally follows that the webs adjacent will close in on the top center and open out on the bottom.

It is advisable to check over the webs twice a year, and the test should be made when the engine is cold. When the engine is being overhauled, it is a wise policy, if the shaft is in correct alignment, to measure with a depth gage each bottom half bearing to the nearest 0.001 in. It may happen a bottom half runs hot and needs renewing; having these dimensions, a new bottom half may be scraped up and adjusted in a few hours.

The Visual Comparison of Belt Slip

By Viggo Sahmel*

SOME time ago the machine illustrated in Fig. 1 was developed to demonstrate visually the relative slip of a short-center drive and of an open-belt drive.

A motor-driven lineshaft carries three small pulleys of equal diameter, which are connected respectively by belts to three large pulleys, also of equal diameter. One of the pulleys, which will be called the timing pulley, runs free, while the other two pulleys are fitted with prony brakes. One of the brake pulleys is belt driven by the short-center drive and the other by an ordinary long-center drive. The frames carrying the

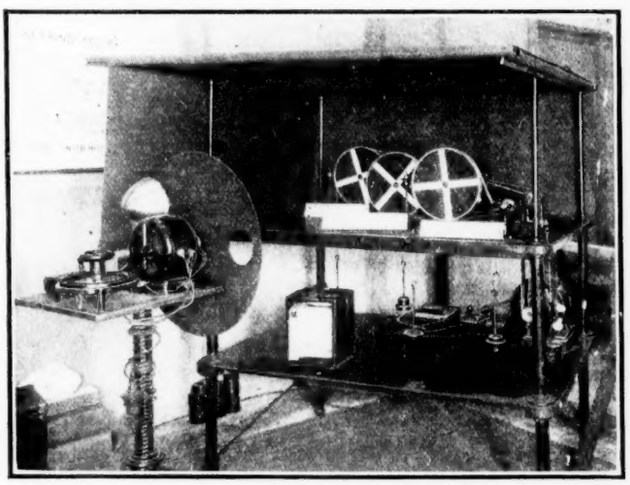


Fig. 1—View of machine for measuring the slip of belt drives

large pulleys are balanced upon pivots and counterweighted, so that equal bearing pressures can be produced on each pulley bearing and approximately equal initial tensions in each belt.

Upon the web of each of the large pulleys is marked a white cross. The three crosses are illuminated by a flicker lamp synchronized with each quarter revolution of the timing pulley. If the two pulleys carrying prony brakes are running at the same speed as the free pulley, the crosses upon each of them will always be illuminated when in the same position and will appear

*Mgr. Lenix Dept., F. L. Smidth Co., N. Y.

to be standing still, but if the two brake pulleys are going, say, 1 per cent slower than the timing pulley, each cross will then be 0.01 of the circumference of the circle behind the position occupied at the time of the previous illumination, and will appear to the eye to be rotating backward. This phenomenon is frequently noticed in moving pictures where we have all seen a locomotive, for example, pulling into the station with the wheels spinning backward.

Computing the Actual Slip

The actual slip may be computed by comparing the time of one backward revolution of the observed image of the cross with the speed of the pulley. The slip in per cent is then 100 times the number of revolutions made by the cross in a minute divided by the number of revolutions made by the timing pulley in a minute. As the lag behind the timing pulley is cumulative, the magnitude of the slip may be determined with almost any degree of accuracy required.

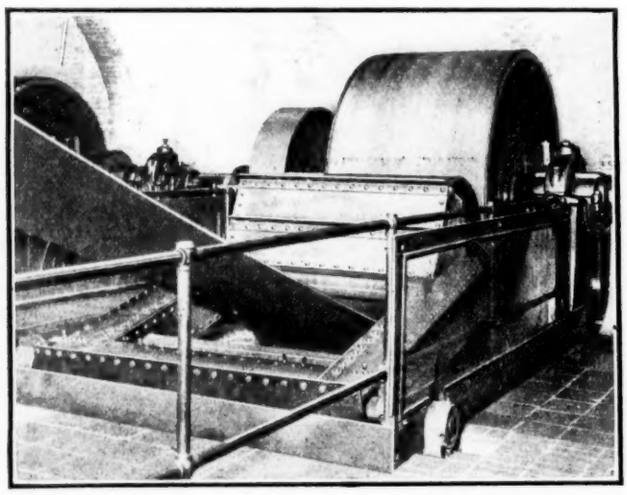


Fig. 2—Typical short-center drive installation

When this test was first proposed and the apparatus set up in the plant of F. L. Smidth & Co., New York City, the delicacy of this method was not appreciated and only ordinary care was given to obtaining equal pulley ratios. The pulleys were first made with crowns in the usual way, but it was found that the belts would work to the side of the pulleys and thus change the effective diameter of the pulley and consequently the pulley ratio. Accuracy in ratio of the pulleys was obtained by turning all at one operation and without crowns. Although the results were improved, it was still impossible to make all three crosses remain stationary at no load, until it was suggested that possibly the belts were not of equal thickness and belts made from tracing paper and of uniform weight were substituted. A heavy load could not, of course, be carried, but the results were at least consistent. By careful selection of leather and by buffing the belts to uniform thickness, the desired results were finally obtained with leather belts. It was also noticed that belts did not give the same results when turned hair, as when turned flesh side to the pulley, but that the neutral axis of the belt (and therefore the mean effective diameter of the pulley) is closer to the hair than to the flesh side of the belt.

Starting with equal pulley ratios and equal belt thickness, at no load both the short-center-driven and the long-center-driven crosses will stand still. On applying a light load, both crosses will start to rotate slowly backward, the cross on the long-center drive pulley rotating a little faster than the cross on the short-center drive pulley. However, as the load increases without changing the belt tension, the cross on the long-center drive pulley will rotate backward at an increasing rate, while the cross on the short-center drive pulley will rotate about as before. By the time the slip on the open drive has reached 3 or 4 per cent, the slip on the short-center drive will still be within 1 to 2 per cent. If the load is still further increased the open-drive belt will jump off at a load where the short-center drive still has a large reserve capacity. Fig. 2 shows a typical installation of the short-center drive.

How to Get a True Analysis of Boiler Blowdown

By Lawrence Washington

When considering the chemical analysis of a sample of boiler blowdown, distilled water from evaporators, evaporator blowdown, or any other sample taken at a temperature greater than the boiling point at atmospheric pressure, a correction should be made for the quantity of water lost through "flashing" or boiling when the pressure on the sample is reduced to atmospheric.

Commercial analyses are reported in terms of the water sent to the laboratory, whereas this water is actually more impure than the water in the boiler drum, since practically none of the solid impurities are lost through the flashing that occurs when the sample is taken. That the neglect of this flash loss may cause an error of 20 per cent or more under modern high-pressure conditions is shown by the following example:

Suppose we wish to know the concentration of solids in a boiler operating at 300 lb. gage. The water in the drum will then be boiling at 422 deg. F., the saturation temperature of steam at 300 lb. gage. From the steam tables we find that under these conditions the heat of the liquid is 397 B.t.u. per lb. Upon withdrawal from the boiler the sample is reduced to atmospheric pressure, at which the heat of the liquid is 180 B.t.u. per lb. (at sea level). Each pound of water withdrawn will therefore have 397—180=217 B.t.u. excess heat content, which must cause the formation of "flash" steam. Since the latent heat of evaporation at atmospheric pressure is 970 B.t.u. per lb., the amount of flash will be 217÷970=0.224 lb. per pound of water withdrawn. Therefore, 22.4 per cent of the water in the sample will be lost through flashing, and only 77.6 per cent will be sent to the laboratory for analysis. The true concentration of a given solid in the boiler drum will consequently be only 77.6 per cent of the value reported in the laboratory analysis. The higher the pressure, of course, the greater will be the difference between the concentrations of impurities in the boiler and in the collected sample.

Few troubles have been encountered in the adoption of multi-stage feed heating in central stations. The time is ripe for industrial plants, whose layout permits, to adopt feed heating in at least two stages.

Installation Problems of a Uniflow-Engine-Driven Centrifugal Pump

SINGLE-CYLINDER reciprocating uniflow engine preferred to triple expansion. Foundation was installed without a layout drawing after set was aligned.

ALTHOUGH the large reciprocating engine pumping unit of slow speed and great inherent reliability has not lost its ancient prestige as a high-duty performer, nevertheless a single-cylinder engine-driven centrifugal pump was decided upon for an additional unit at the Ward Street Pumping Station of the Metropolitan Sewerage Works, Boston, Mass.

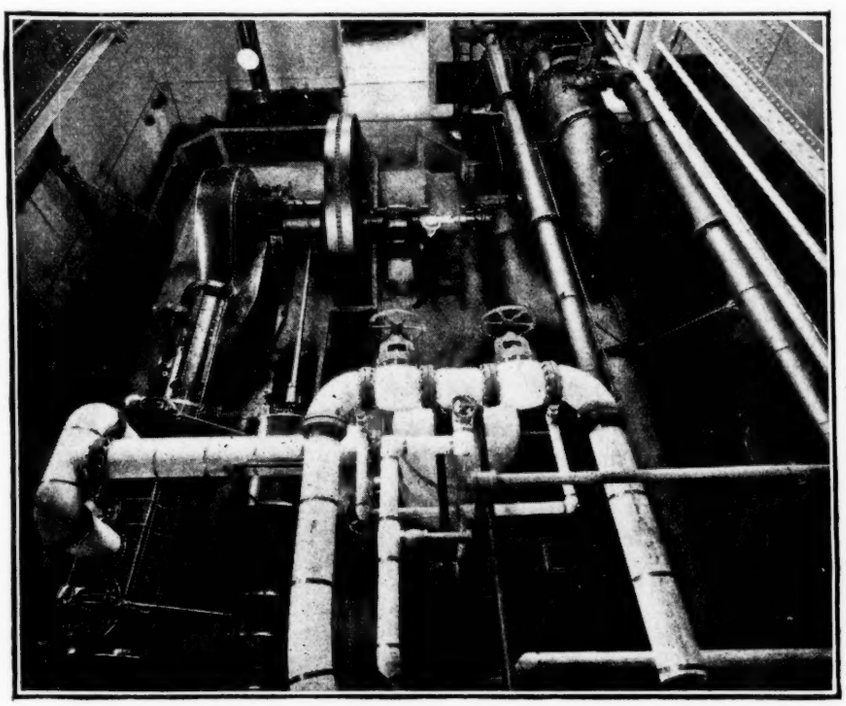


Fig. 1—Uniflow-engine-driven pumping set requires about one-fourth headroom of vertical triple-expansion engine unit

Conditions have obviously changed in the twenty years since the two triple-expansion, 24-r.p.m., 50,000,000-gal. pumps were installed for sewage disposal. The new unit of 150 r.p.m., or about ten times this speed, contains much less material as well as requiring vastly less machine work The first cost was so much lower than that of the older type that it more than compensated for the somewhat lower duty of the smaller unit. Thus the guarantee of 107,000,000 ft.-lb. developed per 1,000 lb. of steam at 150 lb. gage saturated steam used is nevertheless commercially justified as against about 160,000,000 ft.-lb. guaranteed for the original type of pump which involves much greater first cost and consequently higher fixed charges.

Maintenance of the reciprocating pump valves is an undesirably large item. The valveless centrifugal pump was on this account to be preferred, as well as because it was easier to regulate in connection with a constantly varying load.

There are facts, however, connected with the layout and installation that one would not readily anticipate from such a brief statement of the situation. To begin with, the centrifugal unit as designed was about five feet wider than the building space allowed. It was made to fit by eliminating one of the pump bearings. The set was finally furnished with a bolted flanged coupling instead of a flexible type. Thus the two engine bearings and two pump bearings as originally planned, were reduced by one pump bearing. The rigid coupling placed next to the engine, Fig. 1, enabled the weight of that end of the pump rotor to be carried by the adjacent engine bearing, so that the pump could then be placed nearer the engine, in order to fit in the narrow space provided.

Taking care of the exhaust steam was the main problem. Sewage that had been passed through a grill of bars 1½ in. apart was the only available cooling medium. Barometric condensers as provided for the older vertical units with exhaust openings about 40 ft. above the sewage tunnel were undesirable on account of their height above the uniflow cylinder as well as the necessity for an air pump and tendencies to flood over into the engine exhaust and vacuum pump. A type of condenser was here provided which required no air pump, could be operated by sewage at 7 lb. pressure and required no more headroom than the centrifugal pump.

Cooling water is supplied at the top of the condenser, Fig. 2, and given a substantial increase of velocity through it by means of a nozzle. Guide openings are provided for diffusing the exhaust steam uniformly around the water jet, so that condensation and sufficient air absorption takes place. A tee was placed directly above the condenser so that a vertical rod could be inserted through a gland at the top of the tee if it should become necessary to remove a lodgment of sewage in the condenser. The discharge water passes through an orifice below the condenser

before entering the sewage main. Thus a column of water is maintained over the orifice. The well is vented to allow escape of entrained air.

There are two devices to prevent water backing up into the engine exhaust pipe. The usual float valve operating a steam-controlled butterfly valve is attached to the condenser. In addition a bucket-operated vacuum breaker and check valve is used on a vertical section of the engine exhaust pipe. If water is projected downward, it will lodge in the bucket, causing immediate lowering and valve closure, and an air valve then breaks the vacuum.

The sewage supply for this condenser is bypassed around the centrifugal pump, representing 3 per cent of rated output which covers all condenser loss.

A thermal gain through the installation of this unit was effected by using a primary heater, as in Fig. 2. Feed water for the station is heated to within about six degrees of exhaust-steam temperature, while the loss in vacuum through the heater is guaranteed not to exceed 0.15 in. of mercury.

The base of the engine vertical exhaust pipe constitutes a reservoir for removing water passing out with the steam. A perforated plate allows condensation to filter through, but retards the upward motion of water in appreciable volume which might be caused by an abnormal condition, such as a sudden fluctuation in the steam flow. A vacuum trap at a lower level is arranged to take care of the drip water. There are three right-angle turns and an expansion joint between the engine exhaust flange and the non-return valve in the condenser line, so that pulsations of the exhaust steam are deadened considerably so as to prevent appreciable fluctuations of condenser pressure.

With regard to the pump layout an unusual condition was presented in connection with the discharge check valve. A multiple-disk valve was the logical choice for so large a line as 36 in. diameter in order to reduce or eliminate hammering. On account of the probable cost of maintenance and possible delays for maintenance with the nature of the sewage pumped, a large single-disk swinging check valve was decided upon. A plan was worked out to prevent hammering when starting up and shutting down which gave absolute satisfaction. A 16-in. bypass around the pump, shown at the extreme right, Fig. 1, made it possible after priming to maintain the pump discharge at a lower pressure than would open the check valve. On throttling the bypass, the discharge pressure is adjusted easily so as to open the check with a positive motion which prevents hammering. On shutting down the pressure can likewise be controlled so that no noise is audible in the check valve.

The pump is primed by means of an ejector at the upper floor level. The vertical 3-in. pipe connected to the top of the pump discharge, Fig. 1, leads to the ejector to which clean city water is piped for purposes of flushing out dirt. A ball float indicator at the top shows when the line is full of water, the priming of the pump then being complete.

A rather unfortunate situation arose with regard to erecting the unit, inasmuch as no appropriation was found available which could be applied directly. This difficulty, however, proved to be of minor importance as it developed that two experienced men usually employed in repair work could be assigned to this job. About one year was required for installing the unit, and so well was the work done that the erecting man sent by the engine manufacturer found only one adjustment to be altered.

No layout drawing for the foundation was made. Matters were greatly simplified by setting the unit upon brick piers. It was then aligned and piped, after which forms were constructed which allowed ample room for future disconnecting of pipe joints. The completed concrete foundation therefore "fitted" perfectly without laborious layout checking, and besides a highly accessible and practical design resulted. Large capstones had originally been provided for the setting of a third engine unit, but the shape of these did not correspond with that required for the centrifugal set, so that in some instances it was necessary to span spaces between capstones with reinforced concrete construction.

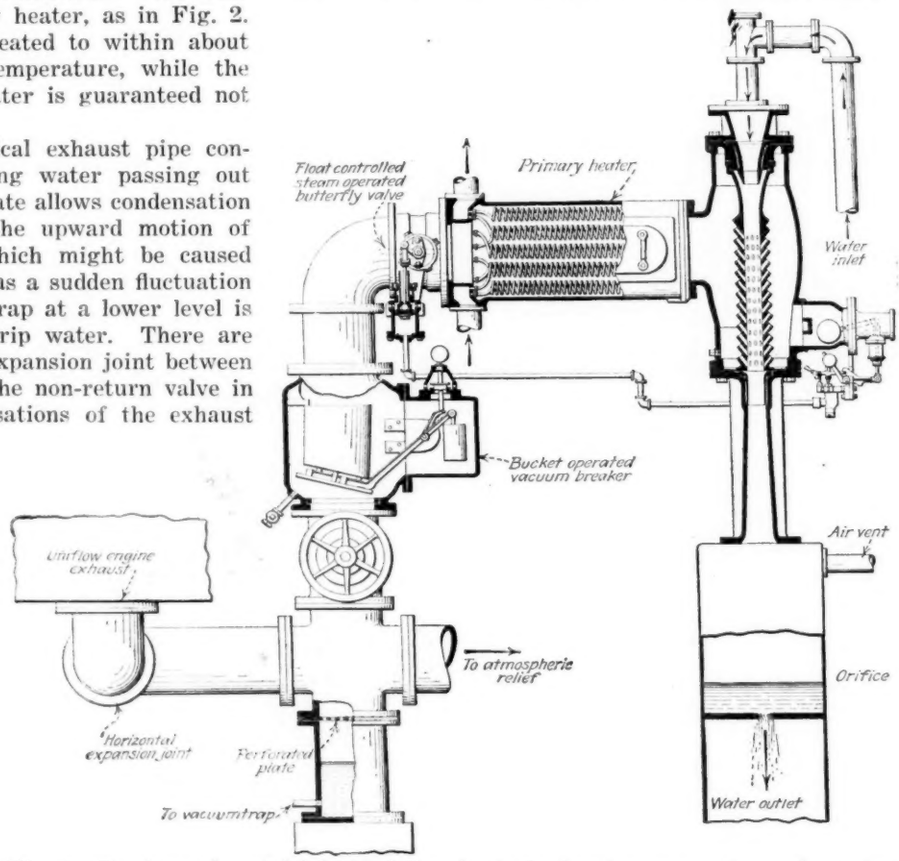


Fig. 2—Engine exhaust in drained line heats feed water on way to condenser and is prevented from flooding by two devices

Operation to date has not disclosed the slightest trouble, thus testifying to the skill and thoroughness of the erectors.

A desirable characteristic of low-head centrifugal pumping has been brought out. Since there is great variation during the day in the rate of flow of the

sewage, much hand regulation of the reciprocating engine pumps is required. The centrifugal unit, however, needs comparatively little regulating, usually about twice a day, on account of the fact that it is to a considerable extent inherently a self-regulating type of machine.

When the sewage flow is high, the sewage level in the intake tunnels rises. The pumping head becoming less, the tendency is to handle a larger volume of sewage, the engine governor holding practically constant speed. Plunger pumps, however, would not pump more, even with lower head, unless the speed were raised, and therefore require close hand speed regulation according to variation in sewage level. With the centrifugal low-head pump a difference in suction level of 4 ft. represents 10 per cent of the pumping head, which gives a change in pumping capacity of about 20 per cent. Another advantage is the fact that the new unit may be started up in about one-third of the time required for the triple-expansion sets.

The fact that there has been no shutdown of this station during the twenty years of its existence speaks well for the caliber of the operating force. The two original engines had made 75,175,070, and 73,745,058 revolutions respectively, as registered at noon of July 29, 1925, the equivalent of six years' continuous operation at full speed for each machine.

The 535-hp., 24x40, 150-r.p.m. Nordberg Uniflow engine is connected to a 36-in. centrifugal pump built by Morris Machine Works. The special eductor condenser was furnished by Schutte & Koerting Co. and the heater by the Griscom-Russell Co. The contracting engineers were Starkweather & Broadhurst, Inc., of Boston. F. D. Smith, chief engineer of Sewage Division, Metropolitan District Commission, Boston, and Messrs. Francis and Goodwin of the District Commission Mechanical Force were largely responsible for the success of the installation.

Making High-Pressure Vessels Tight

By D. J. Champion

The engineer of today finds himself confronted by the problem of higher pressures and the increasingly difficult problem of keeping high-pressure vessels steam-tight. The increase in steam pressures from 150 to, say, 400 lb. cannot be cared for by merely increasing the strength of the various members involved; the essential factor too often ignored is the accuracy in the workmanship.

The design of high-pressure vessels is more difficult than in the ordinary vessel, but it is based on proved engineering principles and can be depended upon. The execution of such a design, however, is a different matter. Heavier plates introduce new problems. By careful and intelligent inspection during melting, cropping, rolling and shearing, a manufacturer is quite assured of the quality of his plate material. Planing, drilling, and reaming are mechanical operations requiring care, but not involving the radical departure in fabrication that might be expected.

The real problem is that of rivets and riveting, the final step in the assembly process. Bull riveting has reached a point where we can consider it almost an art because of the skill of the modern operator. He knows his heat, his power and pressure, and the time element necessary, to a fine degree of precision. However, his skill is of little avail unless the rivet used is correct in design and material. On this little piece of metal hangs the fate of the entire enterprise; it represents the difference between success and failure.

A rivet may be considered as consisting of three parts, the head, the shank, and the driven head. Each part has its own functions and must perform them in co-operation with the other parts if the rivet is to fulfill its purpose satisfactorily. The two heads alone are useless without the tensile strength of the shank. They hold the plates together assisted by the shank and the gripping prevents the plates from leaking. The shank furnishes the strength for the heads; its other important function is to fill the hole. If it does not do this perfectly, a leak will be caused, and the heads will not stop it.

Usually, when a rivet leaks, the manufacturer must resort to calking. Calking seals the head and will effectively stop seepage at ordinary pressures, but at high pressures calking will not maintain the rivet's resistance to the leak. It may withstand the inspection test, but it will not withstand the test of service. The only way to seal a rivet hole permanently is to fill the hole completely. There can be no side-stepping of this issue, and to fill completely means from one end to the other. Scale way under the head will crack off and get into the hole, preventing perfect upsetting up to the surface of the plate. Fins along the shank interfere also. They are dense enough to resist compression, and the upsetting of the shank by great pressure has the tendency to force the fin into the body of the shank, thereby distorting the adjacent metal, producing a minute groove on each side of the fin. This condition eliminates the possibility of a completely filled hole. The diameter of the rivet shank must be as close to the size of the reamed hole as possible. A clearance of 0.03125 in. between the rivet and hole before the former is squeezed is possible. A slight out-of-round variation, not more than 0.0156, is permissible, as the bull riveter will have enough capacity to overcome that deviation in the upsetting process.

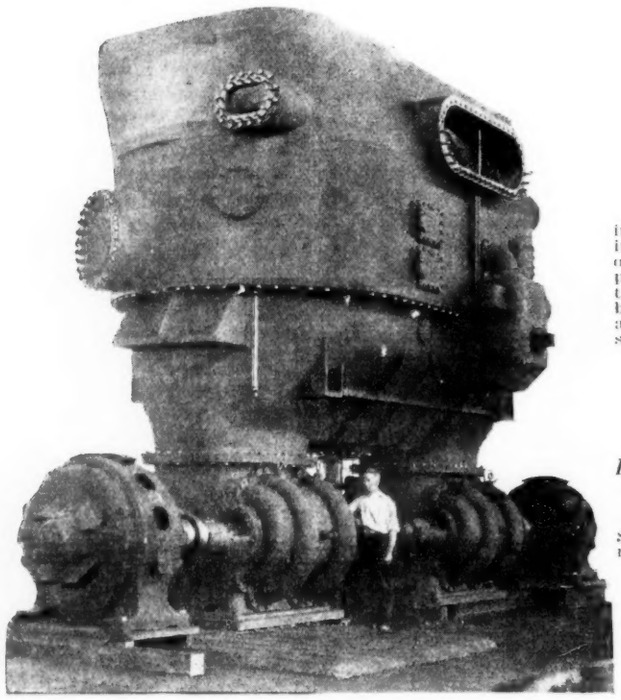
Summing up the situation, it may be stated that the rivet must be free from scale under the head, must have no fins or seams, must be concentric, must be round within 0.0156 in. and be within 0.0156 in. of the normal size. With these requirements and high-class labor and machinery, satisfactory high-pressure vessels can be constructed.

The A.S.M.E. Steam Turbine Test Code

In the issue of *Mechanical Engineer* for September, 1925, there appeared a preliminary draft of the proposed Test Code for Steam Turbines, which has been in preparation for five or six years, and is now advancing toward final acceptance. During the coming annual meeting of the A.S.M.E., Nov. 30, to Dec. 3, 1925, there will be a public hearing at which this code will be thoroughly discussed.

Now is the time for everybody interested in the matter to look up this preliminary draft of the code and study it carefully. Objections should be presented at the public hearing or in writing to the committee beforehand, and not after the code has been finally accepted and published. If nobody is heard from beforehand, it will naturally be assumed that everybody is perfectly satisfied with the code as it stands.

Three Big Ones



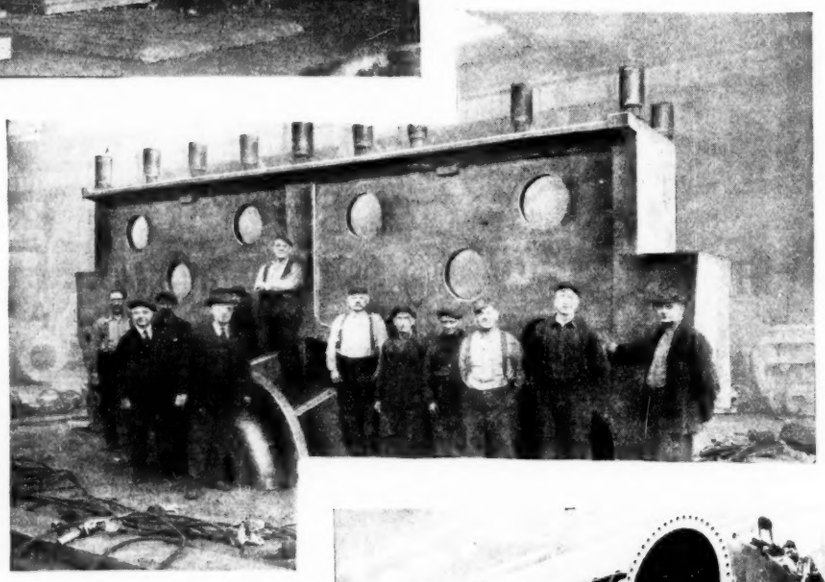
Left—Largest single jet condenser ever constructed

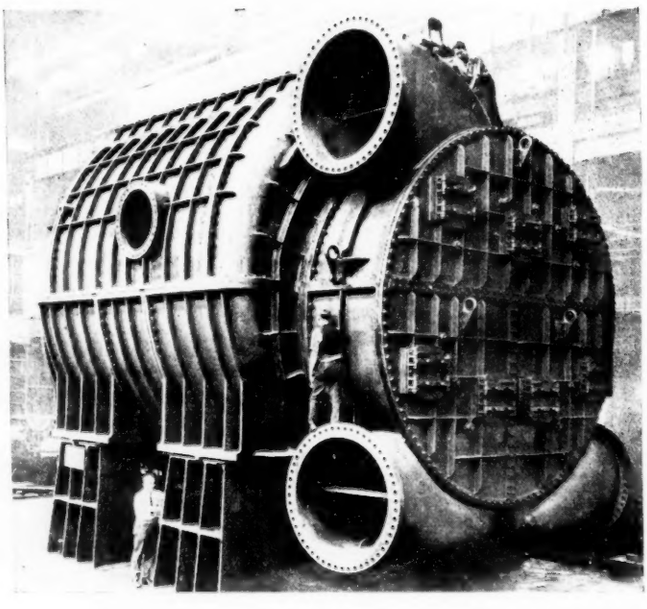
This condenser, which is to serve a 35,000-kw. turbine in the enlarged plant of the Narragansett Electric Lighting Co. (Providence, R. I.), will use 36,000 gal. per min. of cooling water. Heretofore it has not been considered practicable to construct such large jet condensers in other than twin units. The water is sprayed in vertical sheets between which the steam passes. At 29-in. vacuum, about 200 cu.ft. of free air per minute is handled by the steam-jet air ejectors.

Photo by courtesy of Elliott Company

Below—Sixty-five-ton casting for one-half of exhaust hood of 60,000-kw. turbine

This shows the largest casting ever made at the Schenectady works of the General Electric Co. It measured over 26 ft. in length.

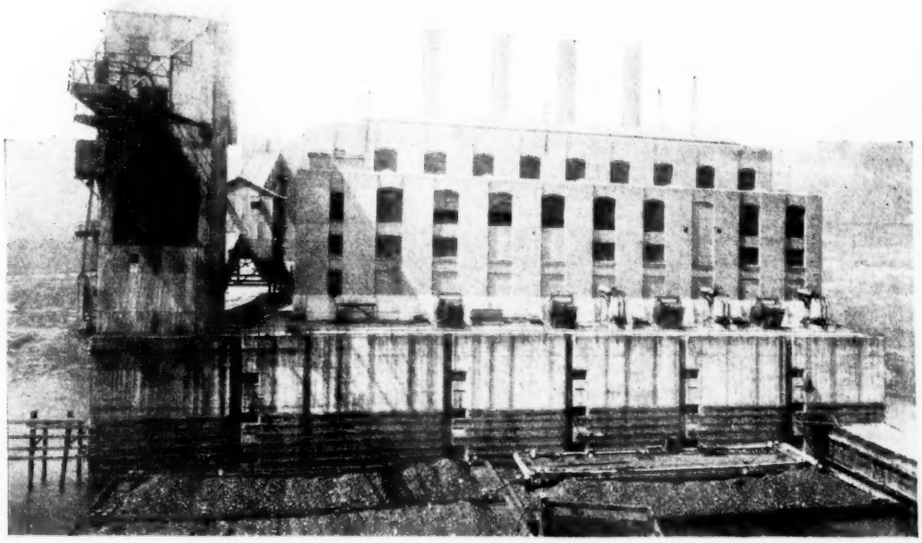




Right—World's largest single condenser

This 70,000-sq.ft. surface condenser, 30 ft. high and weighing (with auxiliary equipment) 985,000 lb., is to be installed in the new Richmond Station of the Philadelphia Electric Co. The 12,734 one-inch tubes, having a combined length of 51 miles, will carry a maximum of 144,000,000 gal. of circulating water in 24 hours with both pumps running. This is about half the normal city water supply of Philadelphia.

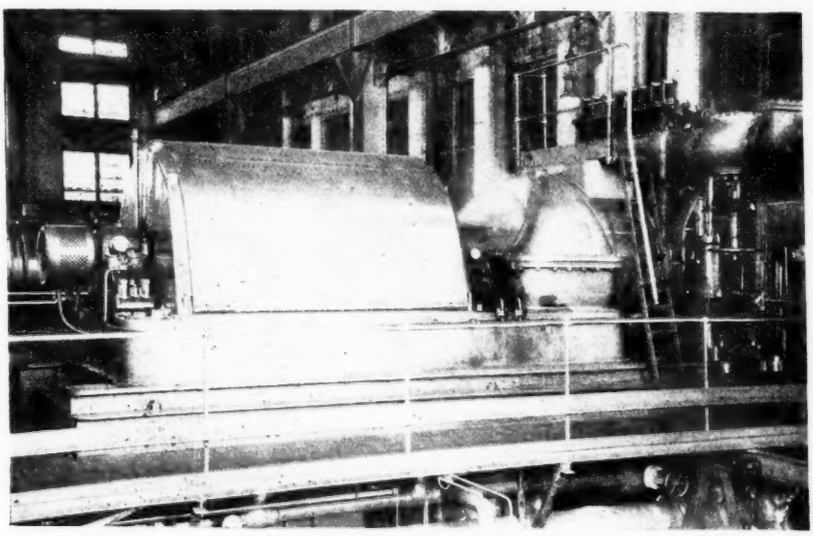
Photo by courtesy of Westinghouse Electric & Manufacturing Co.



Right—First section of Toronto Station of Ohio River Edison Co.

This section, of 66,000-kw. capacity in two units, first went into operation in May of this year. Note the high watertight walls to protect the plant from Ohio River floods.

Photograph by Courtesy Stevens & Wood, Inc., designers of the station.



Left—Larger turbine on old base

A 6,000-kw., 3,600-r.p.m., steam turbine has been mounted on the base formerly occupied by a 3,500-kw. 1,800-r.p.m. unit in the power plant of the River Works of the General Electric Company at West Lynn, Mass. By elevating the larger unit with I-beams so that the exhaust would come in the right place, it was found possible to use the same auxiliaries as were used with the smaller one.

Right—Portion of the chemical laboratory in the Hudson Avenue Station of the Brooklyn Edison Co.

The chemical laboratory is completely equipped not only for testing ash, coal, oils, etc., but for making microscopic examinations of condenser tubing, steel and other metals. An adjacent physical laboratory is used to test and adjust the many instruments in the station.

Power and Heating for the Small Manufacturing Plant*

By DAVID MOFFAT MYERS
Consulting Engineer, New York City

WHEN the heating demand for low-pressure steam is large and reasonably steady, it will pay to install an engine, using the exhaust steam for heating. The combined cost will be less because the generation of low-pressure steam costs almost as much as the generation of high-pressure steam.

THE greatest element of cost in the generation of energy by steam is the fuel cost. In a plant where all the exhaust steam from turbines, engines and pumps can be utilized for heating or process work, the fuel cost of power is far less than that of the largest and most modern of our carbo-electric generating stations.

Even in small manufacturing plants having maximum power demands of 100 kw. to 500 kw., the foregoing statement holds true and the majority of our factory plants require a load demand of 500 kw. or less.

This condition of economy, even in the small plant, arises from the fact that when the exhaust steam is used practically all the heat of the steam is conserved; whereas, where it is not utilized or where the prime movers are run condensing, all the latent heat of the steam is lost. Thus in the small plant with prime movers having water rates ranging from 16 lb. to 60 lb. of steam per indicated horsepower-hour, 84 to 96 per cent of the initial heat remains in the exhaust after passing through the engine or turbine. When this heat can be utilized to replace live steam from the boilers, the latent heat is conserved, which results in an over-all efficiency several times greater than can be secured in any steam plant whose duty is the generation of power alone.

Even in our great central steam stations, where a kilowatt-hour produced for 18,000 B.t.u. is considered a fine record, only 19 per cent of the heat of the coal is made available as a useful product in the form of electrical energy.

In a paper on the heating value of exhaust steam, presented at the 1915 annual meeting of the American Society of Heating and Ventilating Engineers, I deduced a formula for determining the percentage of heat left in the dry portion of the exhaust steam after passing through and performing work in any type of prime mover. These values are shown on the curves presented and are accurate within ½ to 2 per cent, this being the general range of radiation loss through prime movers.

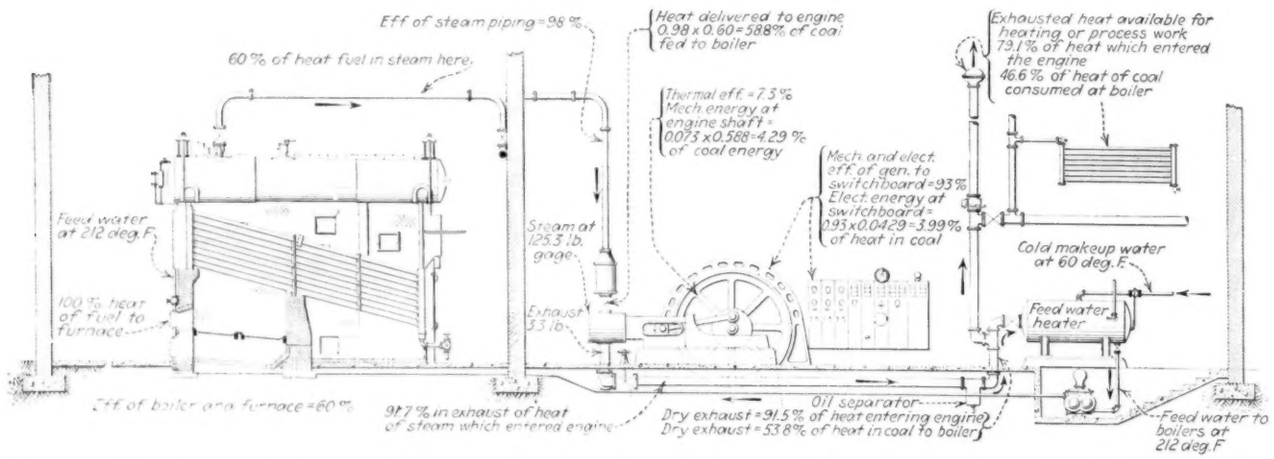

Eff of steam piping = 98 %
60 % of heat fuel in steam here.
Heat delivered to engine 0.98 x 0.60 = 588% of coal fed to boiler
Exhausted heat available for heating or process work 79.1% of heat which entered the engine 46.6 % of heat of coal consumed at boiler
Thermal eff = 7.3 % Mech. energy at engine shaft = 0.073 x 0.588 = 4.29 % of coal energy
Mech. and elect. eff. of gen. to switchboard = 93 % Elect. energy at switchboard = 0.93 x 0.0429 = 3.99 % of heat in coal
Feed water at 212 deg. F.
100 % heat of fuel to furnace
Steam at 125.3 lb. gage
Exhaust 3.3 lb.
Cold makeup water at 60 deg. F.
Feed water heater
Eff of boiler and furnace = 60 %
91.7 % in exhaust of heat of steam which entered engine
Oil separator
Dry exhaust = 91.5 % of heat entering engine
Dry exhaust = 53.8 % of heat in coal to boiler
Feed water to boilers at 212 deg. F

Fig. 1—Heat available at the exhaust of a typical non-condensing 500-kw. factory plant equals about half the fuel energy and three-quarters of that in the steam generated

It may be interesting to state that the formula and the curves were later confirmed throughout by tests made by Professor Lockwood at Yale University, for the purpose of determining by actual experiment the same values that were the object of my theoretical deductions.

A simple example will serve to illustrate the advantage of the small plant, using its exhaust steam, over the central station from the viewpoint of fuel economy.

A central station of 50,000 kw. capacity working on 18,000 B.t.u. of coal per kilowatt-hour developed would have a coal consumption (with coal at 13,500 B.t.u. per lb.) of 1⅓ lb. per kw.-hr., very fine efficiency.

A small factory plant of 100 kw. capacity with an evaporation of 8 lb. of steam per pound of coal, and an engine-generator set using 34 lb. of steam per kilowatt-hour would take 4¼ lb. of coal per kilowatt-hour. Now, if all the exhaust is utilized for heating and process work, the exhaust so furnished will take the

*Abstract of paper presented at the annual convention of the American Boiler Manufacturers' Association, June 2, 1925, at Watkins, New York.

place of about 89 per cent of the total initial steam fed to the engine. Thus only 11 per cent of 4¼ lb., or 0.468 lb. of coal, has been used to generate a kilowatt-hour as against 1¾ lb. required by the central station, which later must suffer a further material loss in transmitting the current to the point of consumption.

TABLE I—HEAT BALANCE OF ENGINE

Heat received = 100		58.8 per cent of heat of the coal
Converted to Mechanical Energy	7.3 per cent	4.29 per cent of heat of coal
To Engine Friction	0.4 per cent	.24 per cent of heat of coal
To Cylinder Radiation	0.6 per cent	.35 per cent of heat of coal
To Exhaust	91.7 per cent	53.92 per cent of heat of coal
Total	100.0 per cent	58.8 per cent of heat of coal

* The exhaust contains 4.8 per cent moisture which we may consider as removed by oil separator and trap. The dry portion of the exhaust contains 91.5 per cent of the heat of the steam which entered the engine and this heat less the slight piping loss goes to the feed water heater and low-pressure piping system.

For the purpose of presenting a real picture of the heat balance in a typical small non-condensing factory power plant, there is included, Fig. 1, a graphic analysis prepared a few years ago to assist the small-plant owner and others interested in gaining a grasp of this problem. The layout and values shown are quite typical of the size of plant (500 kw. and less) we are considering today. Heat balance and calculations are given in Tables I and II. The chief points to be noted are:

1. In the dry part of the exhaust there remains 91.7 per cent of the heat entering the engine throttle. some of this heat in the diagram is used to heat the feed water and saves about 13 per cent of the coal which, without the feed-water heater, would be required.

2. This portion of the heat of the steam is available for heating and process work after it has generated the full quota of electrical energy.

3. The engine has acted virtually as a reducing valve, but has developed useful energy while performing this function. The power is practically a byproduct of the heating and process work if all the exhaust is applied to these purposes.

Figs. 2, 3 and 4 are taken from "Engineering Bulletin No. 2," issued by the United States Fuel Administration in collaboration with the United States Bureau of Mines, as one of a series prepared and published during the war. They show clearly representative heat cycles in four types of plant.

Fig. 2 illustrates an efficient condensing plant such as would mark good practice of this sort in a fair-sized industry. There is no heating considered. Power alone is developed. Delivered at the switchboard in electric energy is 11 per cent, or about one-ninth of the heat in the fuel consumed.

Figs. 3 and 4 apply to small factory plants of the capacities here being considered, 500 kw. and less in power demand. Fig. 3 presents again a case of no heating requirements and shows a net efficiency of 5.6 per cent and 8 per cent for non-condensing and condensing plants respectively. Note the huge waste of fuel in the exhaust steam both for condensing and for atmospheric exhaust.

Fig. 4 indicates the cycle with a simple non-condensing engine whose exhaust is completely utilized for heating and process work and shows a heat and fuel efficiency of 63 per cent, including both power and exhausted heat. This is directly comparable with the 19 per cent efficiency of the highly organized central steam station previously mentioned.

The heat cycle may be computed for a proportion of

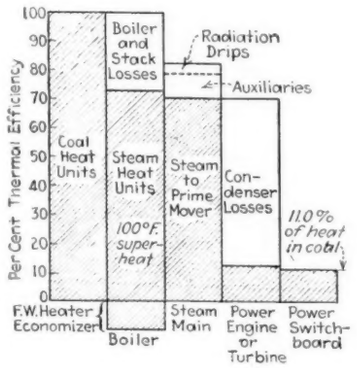


Fig. 2—Well-designed condensing plant converts one-ninth of the fuel energy into electricity

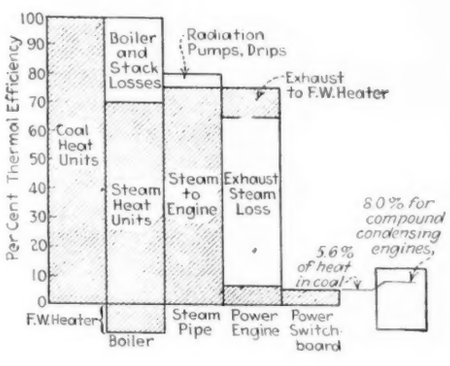


Fig. 3—Small plant utilizes one-twelfth of fuel condensing and one-eighteenth non-condensing

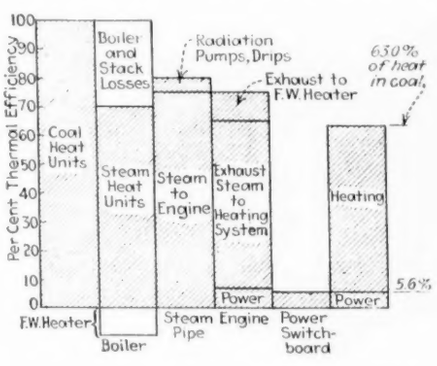


Fig. 4—Plant utilizing exhausted heat converts two-thirds of fuel into useful energy

utilizable exhaust and, as a matter of fact, each case must be considered separately on its merits.

Plant owners often propound this question: "Is it not cheaper to buy our power and light from the central station and generate steam at low pressure for heating?" The answer is: It might be in a small plant if the heating requirements are small and variable in comparison with the power requirements. If, on the other hand, the heating portion of the total requirements is large, it will pay to install an engine and let

TABLE II—CALCULATION OF EXHAUST HEAT AND MOISTURE

Heat in dry portion above 212 deg. F. of the back pressure = 974.2 B.t.u. per lb.
Total heat in exhaust mixture per cent of initial steam = 91.7 per cent
Temperature of water in exhaust mixture = 222.4 deg. F.
Heat above 212 deg. F. in one lb. of the moisture = 10.4 B.t.u.
X = Weight of steam in one lb. of exhaust mixture.
$1-X$ = Weight of moisture in one lb. of exhaust mixture.

$$974.2X + (1-X)\,10.4 = 917 \times 1{,}012$$

X = 952 lb.
$1-X$ = 0.048 lb.

The exhaust mixture per lb. contains 0.952 lb. dry steam and 0.048 lb. moisture. the total weight being the same as that of the steam entering the engine. Hence the dry portion of the exhaust contains:
$0.952 \times 974.2 = 0.927$ B.t.u.

or $\frac{927}{1{,}012}$ = 91.5 per cent of total heat, above 212 deg. F. entering the engine.

Heat in one pound of dry exhaust at 3.3 lb (above 60 deg. F.) = 1126 B.t.u.
Heat to raise one lb. of water from 60 deg. F. to 212 deg F. = 152 B.t.u.

Per cent of dry exhaust to heat feed water $\frac{152}{1126}$ = 13.5 per cent fig. above 60 deg.

Thus:—The heating of feed water reclaims $\frac{152}{1012}$ or 15 per cent of the heat of steam.

Produced at the boiler, above 212 deg. the heat level above which the entire heat cycle of the plant is based.
With a water rate of 34.5 lb. per b.h.p. the engine thermal efficiency is 7.3 per cent.

the exhaust steam do the heating. The power then becomes virtually a byproduct of the heating cost, in which case by comparison purchased power becomes a large and unnecessary expense.

But factory owners sometimes believe that it costs much less to generate low-pressure steam as compared to high-pressure steam. The answer to this, as every engineer knows, is that they have been misinformed.

By lowering the boiler pressure it is true that a lower flue-gas temperature can be maintained, which reduces the chimney loss a certain amount, depending upon conditions. Five or six per cent would be a generous allowance for this gain in efficiency.

We have now discussed the salient features of the steam and fuel aspects of our problem and it remains to touch upon the chief factors of cost, in dollars and cents.

Designing a Plant to Obtain a Steam Balance

The cost of power may be divided into overhead and operating expenses. I have before me the complete operating cost records of a factory power plant where the maximum demand is 500 kw., the steam pressure at the throttle 150 lb. and where there is a small requirement for 110-lb. steam for ovens in addition to the demand for low-pressure steam for building heating. This plant operates condensing and is so designed that exhaust steam in the quantity needed can be applied to building heating, which of course, is a seasonal and variable demand. Thus a proper steam balance is secured at all times. There are many ways in which such a steam balance can be obtained in the design of a plant, either with turbines or with engines, with direct and indirect steam heating or with a hot-water system. Upon the engineering solution of this problem of design depends the degree of economy that will be possible. Each individual problem requires separate study and treatment.

In this case mentioned, the exhaust from the engines is divided between the condenser and the heaters which warm the water which is then circulated through the heating system, the vacuum on the condenser being regulated to suit the weather conditions.

In this plant the total operating cost for last year for power, heat and light, was $42,652. If the boilers had been operated for building heating only with all power units shut down and current purchased for power and light, the coal requirements would have cost $17,016. This is based on similar buildings for this locality of equal cubic contents.

The actual coal consumed for all purposes including power, was $22,268. The ratio, therefore, of heating coal to total coal was $\frac{17,016}{22,268}$ or 80 per cent.

Now in general, most of the charges for power and heat are in proportion to the heating-fuel and power-fuel requirements, with some small and variable exceptions. The extra fuel in this case needed for power was 20 units as compared to 80 units, which would be needed if the engines were shut down. For approximate comparison, then, we may charge 20 per cent of the operating costs against power in this example.

The chief engineers' services could not be eliminated even if power were purchased, as it is usual for him to spend most of his time as master mechanic in charge of all machinery and appliances throughout the factory. The firemen must be retained, and repairmen for all equipment, except prime movers. The electrician must certainly be kept so that this extra charge against power may be considered nothing. The only exceptions in this case are the watch engineer (who could be dropped) and the material portion of the engine-room repairs and supplies.

The 100 per cent charges which would remain on account of the chief engineer, the firemen and electrician, would more than offset the saving in cutting off the watch engineer and engine-room supplies and repairs, so that our ratio of 80 to 20 would remain a safe one. Hence the approximate operating charge against power would be 20 per cent of the total of $42,652, or $8,512, which includes the live steam used for baking purposes. Let this be charged against power to be further conservative.

The total electrical output of the plant was 914,425 kw.-hr., so that the operating charges against power alone are $\frac{8512.00}{914,425} = \$0.0093$ per kw.-hr.

The cost of central-station current for the same demand and energy requirements would have been $30,400, or $0.0253 per kw.-hr., a gross difference of $0.016 in favor of making versus buying, equal to $14,600 a year.

We will now see what the addition of overhead means in this instance. The power unit with piping, foundation and auxiliaries with allowance for space or land value, would not cost at present over $25,000. If we allow 13 per cent for interest and depreciation, we have $3,250 per year, or $0.0035 per kw.-hr., which, added to the operating cost, gives a total cost of $0.0129 for generating versus $0.0253 for buying power. This difference of $0.0124 would amount to $11,340 a year in favor of making the power.

Actually, the power investment would pay for itself in about two years, after which there would be a clear saving of $14,600 a year.

These examples are merely by way of illustration. No two cases are alike. Purchased power has a broad and proper field where its use spells economy to the plant owner. In the small plant where little or no heating is needed and where the electric rates are reasonable, it fills a valuable need. But where a large proportion of low-pressure steam can be used, the small plant can make power cheaper than it can be bought in most instances, and there are hundreds of such plants throughout the country.

Purchased power often fills a need even when making power in the factory is cheaper. Although the private power plant may be capable of showing a good profit as an investment, it sometimes happens that the owner's capital is limited and that a quicker turnover for the same money can be secured by enlarging the production side of the factory. I could recount instances of this kind also.

Erratum—In the issue for Sept. 8, 1925, on page 354, is an article describing a mixed-pressure turbine installed in the plant of the Desbrook Ice Co., of New York. The work of design and installation was credited to William Braun & Co., Engineers and Constructors, 30 Church St., New York City. Unfortunately, however, the name of this firm was misspelled. We regret this error and take pleasure in calling the attention of our readers to the correction.

Coal from the Mine to the Boiler

By JACOB M. SPITZGLASS
Vice-President, Republic Flow Meters Company, Chicago

THE weight of the coal "as received" is no check on the weight of the coal "as purchased," owing to the possible changes of the moisture content during transportation.

Coal as purchased has a definite number of pounds of dry coal per ton. Coal as fired has a definite number of pounds of dry coal per cubic foot. Thus, the volume of the coal as fired may be made to check the weight of the coal as purchased.

A cubic foot of dry or moisture-free coal of a given mixture from a mine, will always weigh the same when loosely filled into a container, and the addition of a given amount of water will only increase the gross weight of the coal, but the weight of the dry coal in the cubic foot will remain constant. Thus comparison should be made on the basis of the pounds of dry coal.

Volumetric measuring of the coal to the boiler gives a definite check on the coal as purchased and, by eliminating all moisture errors from the dry-coal determination, permits accurate figuring of the cost of steam generation.

Coal as Purchased

COAL is purchased by weight, and rightly so, the same as sugar or rice or puffed wheat. Gas is purchased by volume because it cannot be weighed conveniently. Water is purchased either by volume or by weight, as either way is equally convenient.

It is advantageous to purchase coal under rigid specifications and to select the grade and quality suitable for the given power plant. This is usually the procedure followed by large industrial concerns and nearly all central stations in the country. The average power-plant operator does not realize that he can purchase coal by specifications without the necessity of maintaining a laboratory to test the coal. The United States Bureau of Mines has placed at the disposal of the public complete analyses on the coal from all the coal fields in the country. Bulletins 85, 123 and 193 of the Bureau give the analyses of mine and car samples of coal collected by the government in the fiscal years of 1904 to 1919, covering a period of 15 years. Bulletins 119 and 230 cover the analyses of samples of coal delivered for government use during the fiscal years 1908 to 1921 inclusive, and also the analysis of samples collected by samplers of the Bureau of Mines from coal being loaded into railroad cars during the same period. In the case of the coal delivered, the samples were collected systematically throughout the entire delivery of the coal, which ran into many thousands of tons. In the case of the car samples each analysis presents the systematic collection through an entire day's run at the mines.

By consulting these bulletins, the plant operator may select the proper grade of coal suitable for his plant and with the least amount of transportation charges for the delivery of the coal. Numerous samples may be found suitable for a given plant, and the selection based on the given analysis is only a matter of dollars and cents to obtain the product that will be the cheapest in the end.

It is recognized that analyses made of samples collected from the face of the mine will usually indicate a better grade of coal as to ash contents and heat values, than the actual commercial shipment. It is also recognized that, in commercial shipments sampled at their destination, the moisture content may be either more or less than that in the mine samples, the relative proportion depending upon the amount of moisture in the bed, the size of the coal and the weather conditions during transit.

As expressed by an engineer of the Bureau, there may be a considerable difference in the moisture of coal as mined and as delivered. To begin with fundamentals, the moisture on the "as received" basis is made up of two factors, the surface moisture and the inherent moisture. The former is moisture collected on the surface of the individual pieces of coal and is dependent on the size of the particles and the conditions to which the coal has been subjected, after having been taken from the vein in the mine. It is practically zero with coal that has not been subjected to moisture after being mined, and is at a maximum with fine coal that has been hauled and handled in wet or snowy winter weather. The inherent moisture is that occurring in the coal as it lies in the bed; the remainder of the original water contained in the coal forming vegetation. It is highest (in the neighborhood of 30 per cent) in the most recent sub-bituminous coals and lignites of the central and western fields and lowest (almost zero) in the oldest semi-bituminous coals and anthracite. Surface moisture, which is added in preparation or in transit, may be a negative value if the coal is hauled in hot, dry weather, or may amount to 20 per cent in slack coal that has been stored in the open in winter.

Coal "As Delivered"

As the coal proceeds from the mine to the power plant the weight of the coal becomes the only factor under consideration. The railroad is not interested either in the grade or in the quality of the coal. It is the weight of the coal and nothing else that determines the railroad's compensation.

The following information obtained from the Fuel Department of the Illinois Central Railroad, will give an idea of the procedure of transferring the coal from the mine to the bunker in the boiler room. "The coal, when it comes from the mines, is uniform as to dryness or moisture. The washing of coal does not add much moisture as the coal is screened before it is loaded. The carloads of coal are weighed at the mine and the railroad usually accepts mine weight. The allowable variation in weight is 2 per cent between mine weight and railroad weight after rain or snow has fallen on the car. If the railroad weighs the car and finds it heavier, it charges freight on the increased weight if it is over 2

per cent, but the customer buys the coal on the mine weight. The railroad and the mines maintain a weight bureau and send test cars to the mines to check the scales."

The significant part of it is that the railroad is willing to carry 2 per cent of the water-increased weight and no more. If the purchase is made on the basis of the mine weight and if the purchaser is certain that the full shipment was delivered in the carload, he can do no more so far as the weight is concerned. There is no check to offer since the weight of the carload "as received," is not necessarily the same as the weight of the carload when shipped from the mine.

As previously demonstrated, the surface moisture is the only item that may differ in the coal "as received" from the coal "as purchased." Since the change in surface moisture does not change the volume of the coal, therefore, the quantity can be accurately checked by volume if desired.

What is of interest to the power-plant engineer is the fact that a cubic foot of coal of a certain grade, from a given mine, has a definite weight when filled loosely into a vessel. The weight will remain the same except for changes in moisture content. It is not practical to use volume directly for checking large quantities of coal as delivered, since it would be necessary to fill it loosely into measured containers. It is the volume relation, however, that makes it possible, by means of the coal meter, to check the weight of the coal as fired.

Coal "As Fired"

In the foregoing it has been shown that quality is the main factor when coal is purchased and that weight is the principal consideration when coal is in transit. In either case it is a matter of contract between the purchaser and the seller and affects only indirectly the efficient operation of the plant. In the boiler room the operator is concerned with the measurement of the coal supplied to each individual boiler. The operation of the boiler is subject to the actual quality and weight of the coal and not necessarily to the terms of the contract upon which the coal is purchased.

The power-plant operator has two unknown quantities in his problem. If he desires to keep a check on the operation of each individual boiler, he must know the weight and the quality of the coal as fired. If he desires to know the fuel cost per thousand pounds of steam, he must obtain the weight and quality of the coal as purchased.

The Boiler Test Code of the American Society of Mechanical Engineers specifies the record of:

1. Pounds of steam per pound of coal as fired.
2. Pounds of steam per pound of coal dry (moisture free).
3. Pounds of steam per pound of combustible (moisture and ash free).

A boiler test, of course, is intended for the boiler and not for the coal, and therefore there is no mention made of the quality of the coal as purchased or of the pounds of steam per pound of coal as purchased. The fact of the matter is that even after running a boiler test it is necessary to obtain the qualifications of the coal as purchased, in order to determine the fuel cost per thousand pounds of steam. The mere weighing of the coal as fired does not give the information.

To arrive at comparative results in everyday operation, a standard basis for comparison must be adopted. If comparison is based on the weight of coal as fired, the chances are that the coal as fired will differ in the moisture content from day to day and even from boiler to boiler. Even should the coal as fired happen to have the same moisture content as the coal when received, and assuming that the coal received was the same with regard to moisture content as the coal when shipped from the mine, the basis of comparison would not extend from one period to another on account of the possible variation of the moisture when shipped from the mine.

Inasmuch as all the variables in the coal except the moisture can be controlled, the comparison should be made on the basis of the pound of dry coal (moisture free). If the coal as purchased contains 10 per cent moisture (at the mine), there is 1,800 lb. of dry coal per ton. If the total cost is $5 per ton, the cost per pound of dry coal is $500 \div 1{,}800 = 0.28$c. If the same coal as fired contains 15 per cent moisture, a ton of coal as fired delivers to the boiler only 1,700 lb. of dry coal at a price of 0.28c. per pound of dry coal, which is the same as purchased. That is, the cost of a ton of coal as fired is $1{,}700 \times 0.28 = \$4.76$ per ton.

Coal "As Metered"

In metering coal the object is to determine the comparative amount consumed by each boiler, and for intelligent comparison the amount must be determined on the basis of the weight of dry coal supplied to the boiler. While the weight of the same quantity of coal is a variable, depending upon the amount of moisture that may be added to the coal during transportation and handling, the weight of dry coal in a given volume is a constant quantity. It remains the same regardless of increase or decrease in the moisture content of the coal. The use of the dry-coal basis as a comparison has the additional advantage that the amount of dry coal is the same at the mine when purchased, at the plant when received and at the boiler when fired.

It is not the intention to recommend that coal be purchased by the bushel instead of by the ton. Coal could as well be purchased by volume were it not for the fact that in the mutual transactions between the seller and purchaser, it is more convenient to weigh the coal than to measure it. The ton is a better standard than the bushel or the cubic foot for hauling, carrying and handling charges, and it is only right to do it that way. But when the coal is fed to the boiler and it is desired to have an accurate measurement of the amount of dry coal supplied, the volumetric determination is the more convenient and the more accurate of the two methods.

This is the important point. Neither the weight alone nor the volume alone establishes the exact value of a given quantity of coal. If the coal as fired is weighed the moisture content in a pound of the coal must be determined in order to arrive at true values on which to base comparative results. If the coal as fired is measured, then the weight of dry coal contained in a cubic foot must be determined. If these determinations are to be accurately made, the weight of dry coal per cubic foot may be determined in the same manner as moisture is determined; that is, by systematic sampling of the coal as fired.

If, however, average figures are sufficient, which is usually the case, then the results may be based on the scale weight of the coal as fired and an estimate of the moisture content. Such results may be misleading, because the moisture is such a great and uncertain

variable. It cannot be easily controlled in the same stockpile or even in a single carload.

This uncertainty is eliminated when the coal is measured by volume. Reliable information as to the weight per cubic foot of the particular grade and kind of coal is easily obtainable, and the consideration of moisture content is eliminated. For this reason it is more appropriate to use the volume than the weight for measuring the coal. On the same basis the old-time wheelbarrow is to be preferred to the scale for measuring the coal supplied to hand-fired boilers, provided the body is of such shape that equal loadings can be assured.

Measuring the Coal

The use of mechanical stokers and in particular stokers of the chain-grate type, in which the coal flows into the furnace continuously, affords a natural means of measuring the amount of coal supplied to the furnace.

When coal is supplied to a boiler by a chain-grate stoker, the amount of fuel passing under the grate may be regarded as a stream with a constant width, but the depth and velocity of the stream are subject to variation. The width of the stream is the width of the chain grate, the depth is the thickness of the fire, and the speed is the rate of travel of the chain grate. Therefore, if W = the width of the stream in feet, T the thickness or depth in feet and V the velocity of the stream in feet per hour, then

$$\textit{Cubic feet per hour} = W \times T \times V$$
$$= \textit{cross-sectional area } xV$$

Although slack and small coal are not perfectly homogeneous and do not obey the laws of fluids or mathematics exactly, it has been found by experience that under ordinary conditions of working the flow of coal under the stoker gate is, generally speaking, proportional to the thickness of the fire and to the velocity of the grate, and that the results are consistent with what might be expected, theoretically. As the width W is constant, and T and V are the only variables, all that is required is some form of automatic integrating mechanism which will at all times take into account the two items T and V.

A volumetric coal meter may be attached to the driving mechanism of the grate in such a way that the speed of the counter is varied in proportion with the foregoing two items T and V. By passing through the gate a measured quantity of coal, it is an easy matter to determine the volumetric value of each unit registered on the meter.

From data so far obtained it appears that the relation between the thickness of the fire and the height of the gate opening is a function only of the make and size of the stoker and is independent of the kind of coal used. The weight of dry coal per cubic foot is a function of the mixture of fine and coarse particles for any given kind of coal. Inasmuch as slack or small screenings are used almost exclusively on chain-grate stokers, there is only one determination necessary for the make of stoker and kind of coal in order to arrive at the value of dry coal corresponding to the meter units.

For the accurate determination of the weight of dry coal in a given volume the following method has been worked out to eliminate the errors involved in the accepted method of moisture determination. To start with, obtain a bucket or large rail having a volume of about one cubic foot. Place the bucket on a scale, fill it with water to the brim and take the weight. Empty the bucket and obtain the tare. Deduct the tare from the gross weight and obtain the weight of the water. The volume of the vessel is equal to the net weight of water divided by 62.4.

Fill the bucket loosely with coal from the supply to the boiler. Strike off the top and obtain the gross weight. Obtain the net weight by deducting the tare previously obtained. Spread the coal from the bucket on a canvas and allow it to air dry on the top of the boiler for two or three hours. Weigh this dried coal and divide the weight by the volume of the bucket. This item is the weight per cubic foot of the coal free from surface moisture. From a sample of the dry coal the inherent moisture then may be determined in the laboratory and thus the weight of the dry coal is obtained.

It will be noticed that this procedure does not follow the accepted method of moisture determination as given in the A. S. M. E. code. The author is not the first to question the accuracy of the orthodox method of moisture determination. The paper by Alfred Cotton, entitled "The Accuracy of Boiler Tests" (*Mechanical Engineering*, July, 1922, page 427), proves that the orthodox method of moisture determination is subject to serious error. He says in part: "To find out how much moisture there is in the coal, we must have a representative sample, and then we must analyze it for moisture *while it is representative*," which, as he shows, is practically impossible.

Volume measurement eliminates all moisture errors from the dry coal determination because the moisture does not affect the weight of dry coal in the measured volume. The simplicity is evident from the fact that the sample may be taken at random from the supply rather than the representative sample required for moisture determination in the standard method. When the measured volume of coal is air dried, the surface moisture is removed, then the laboratory test on that sample determines only the inherent moisture which is constant for the given supply. Consequently, errors in moisture determination will not be reflected in the weight of the dry coal. On the other hand, if the coal is weighed as fired and a deduction made for the moisture content, a representative sample cannot be obtained and the errors in determination of moisture are saddled upon the dry-coal weight. This is the reason for insistance upon volumetric measuring of the coal to the boiler.

In general, leaky connections on a lubricator will cause irregular feeding of the oil. Should the sight-feed glass become clogged, it may be due to setting up too tightly on the bottom nut when the glass was installed. This often causes the rubber gasket to be squeezed out of place and perhaps into the glass. If the oil-feed cone should become displaced or off center, it may cause the globules of oil to move up the sides of the glass, and perhaps to stick there, causing the glass to fill with oil. The glass should then be removed and the cone filed down, or it will be found effective to solder a fine copper wire to the side of the cone, leading it upward through the center of the glass, nearly to the top. The oil drop will then follow the wire, and the glass will remain clean. It is not advisable to allow a hydrostatic lubricator to run empty of oil, owing to the danger of the sight-feed and gage glasses becoming hot, thus causing oil to stick to the sides of the glass.

Locating Faults in Electric Elevators—Direct-Current Motors

Effects of Conditions in the Power System on Motor Operation—Troubles in Elevator Operation and the Faults in the Motor That May Cause These Troubles

By CHARLES A. ARMSTRONG

FAULTS in electric-elevators may be divided into four classes: 1. Power supply. 2. Motor. 3. Control equipment. 4. Mechanical. On account of the wide variation in the power supply, types of motors, and controllers and the design of mechanical details, an almost infinite number of troubles can occur in elevator equipment.

The foregoing should not be understood to mean that electric elevators, when properly designed, installed and maintained, give any more trouble than any other similar type of apparatus. The truth of this statement is found in the fact that when we get on an elevator to be conveyed to a certain floor in a building, we are pretty sure of having our desires satisfactorily complied with, without any delay due to failure of the equipment. When the wide variety of control is considered, which ranges from a simple main-line and reversing switch on some of the older types of alternating-current equipment to a signal-control installation on modern equipment where the control of a

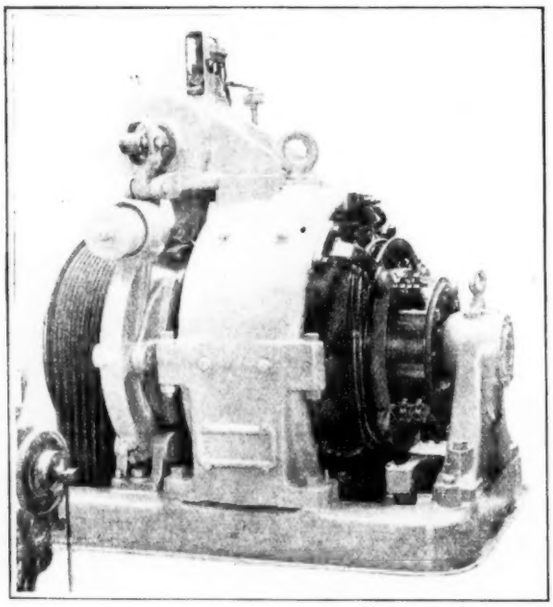


Fig. 1—Direct-traction elevator machine

high-speed elevator is entirely automatic, it is obvious that a wide variety of troubles can develop. This is so much so that the best that can be done in any article is to indicate in a general way how to go about locating the cause of trouble when it does occur.

If satisfactory operation of an elevator is to be expected, the power supply must be correct for the motor and control equipment. If the voltage is low on a direct-current system, it will cause the motor to fail to come up to full speed and may even cause the controller to function improperly. On the other hand, if the voltage is too high it will cause the speed of the

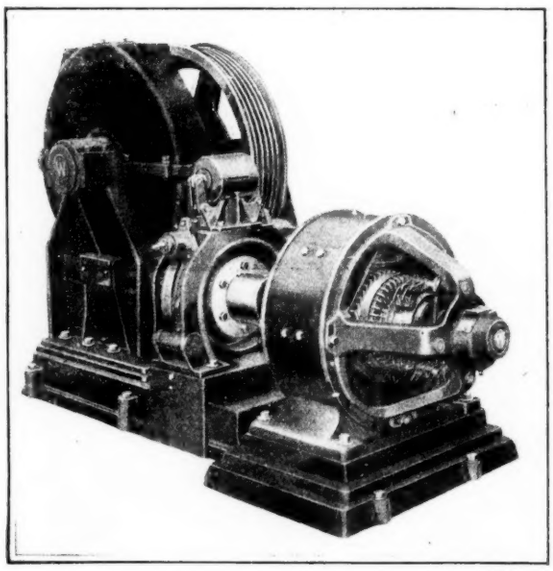


Fig. 2—Geared-traction elevator machine with direct-current motor

motor to be above normal and may cause heating of the field and magnet coils. However, the latter is not very likely on account of the intermittent service. In any case if the elevator service is to be satisfactory the power supply must be up to par. In direct-current work the power supply is less liable to be a factor in elevator operation than with alternating-current equipment, which will be discussed in another article. Direct-current motors used in elevator service are of the shunt or compound types, with or without interpoles. On direct-traction elevator machines, Fig. 1, the shunt-type motor is generally used and operates at speeds around 60 to 70 r.p.m. On geared-type traction machine, Fig. 2, and the drum type, Fig. 3, compound motors of a comparatively high speed are used.

As elevator motors, in general design, are not different from those found in other industrial services, they are subjected to about the same trouble. In direct-current motors these troubles may be divided into, sparking at the brushes, heating, excessive speed, speed too low, noise and failure to start. With some of the earlier types of motors that were not designed for

reserving service, it was not possible to set the brushes in a position to give sparkless operation on the commutator, on account of this position being back of the neutral for any given direction. For reversing service the brushes of the motor must be set on the neutral. With modern type of machines, if other features of operation are correct, the motor will operate sparkless with the brushes on the neutral. Where interpole motors are used, it is necessary to check the position of the brushes carefully.

On account of the frequent starting and stopping the controller must be adjusted so as not to accelerate the motor too rapidly or sparking may result each time the motor is started, which will gradually make the commutator rough and eventually lead to trouble at the brushes. On modern elevator controllers the motor armature is generally short-circuited through a resistance during the stopping period. This causes the motor to act as a generator and develops a braking action that assists the mechanical brake to bring the elevator to rest. If the resistance to which the armature is connected is made of too low a value, the current will be excessive and cause sparking at the brushes during the stopping period. Although this sparking is for only short periods, it will gradually roughen the commutator and cause sparking at the brushes during the full operating period. On most modern elevators it will be found that the discomfort to the passengers in the car will dictate how quickly the elevator can be started and stopped rather than commutation limitation.

In addition to the two conditions that are peculiar to elevator service, there are the faults that cause sparking at the brushes, which are common to almost

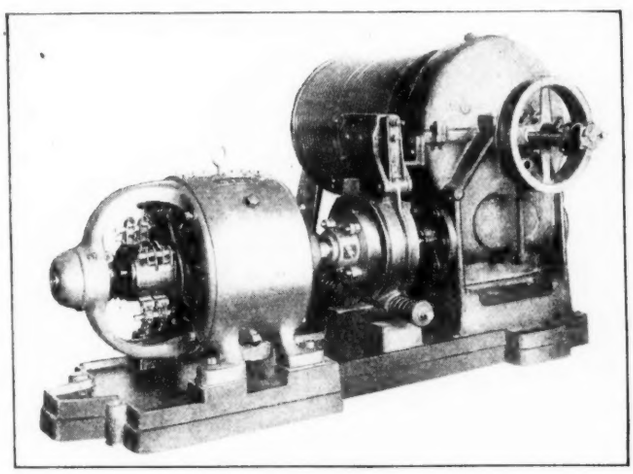
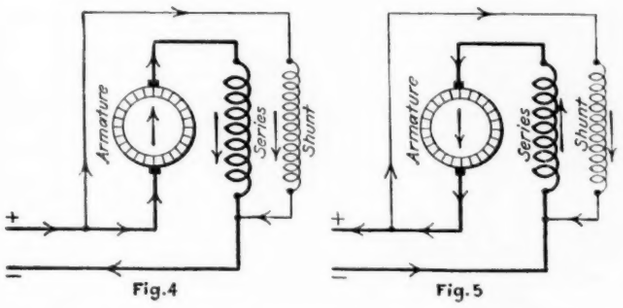


Fig. 3—Drum-type elevator machine with direct-current motor

all direct-current motors, namely: Brushes not set diametrically opposite; brushes not in line with the commutator bars; brushes not in good contact with the commutator, due either to dirt and oil on the brushes or to the condition of the commutator; high mica in the commutator; open-circuits in the armature; short-circuits in the armature; short-circuits in the field coils; wrong polarity of field coils.

Heating of the motor in elevator service is not so likely to occur as in industrial applications where the load may be increased to overload the motor. It is seldom, if ever, that an elevator motor is overloaded long enough to cause serious heating. The brake even if it were adjusted to cause overloading of the motor, would become so hot as to call attention to the condition before the motor would be injured. The chief causes of overheating of an elevator motor are: Short-circuits in the armature or the field coils; moisture in the windings; the windings becoming oil soaked; or the



Figs. 4 and 5—Diagrams of compound motor

Fig. 4—Shows direction of current when the machine is operating as a motor. Fig. 5—Shows direction of current when the machine has been converted into a generator.

bearings worn so as to allow the armature to rub on the polepieces.

On account of the nature of the load it is seldom that trouble is experienced on the motor with hot bearings if they are kept properly lubricated with a good grade of oil. On geared-type machines with disk-type thrust bearings it is possible that these bearings may wear sufficiently to allow the thrust of the wormshaft to be taken on one of the motor bearings, in which case heating of this bearing is likely to develop.

Excessive speed will generally be found to be due to the series-field winding not being cut out of circuit after the motor comes up to speed. In elevator applications the motor may do service as a motor or generator. When the car and its load, in the up motion, are heavier than the counterweights, then the motor has to develop an effort to assist in raising the car and its load. In the down direction, if the car and its load are heavier than the counterweights, there will be a tendency to overspeed the motor, in which case the counter-electromotive force in the armature becomes greater than the applied voltage and the motor becomes a generator and supplies a current into the power system, under which condition the motor acts as a brake to prevent overspeeding. When this change is made from motor to generator with a compound machine, if the relation between the series- and shunt-field winding is correct for the motor, they will be wrong for generator operation. This will be understood by referring to Figs. 4 and 5.

In Fig. 4 the diagram shows the direction of the current through a compound machine as a motor. In this diagram the current in the series- and that in the shunt-field coils are in the same direction, which is correct. In Fig. 5 it is assumed that the motor's speed has been increased, by the elevator car in the down direction, to where it has become a generator and is pumping back into the power system. In this case the direction of the current in the armature and series-field winding is reversed. This gives the series and

shunt-field winding opposite polarity and weakens the field and would tend to reduce the braking current and let the elevator increase in speed. To overcome this difficulty, the controller is so arranged that the series-field winding is only in circuit while the motor is coming up to speed, after which it is cut out of circuit and the motor operates as a shunt machine. Should the controller fail to function so as to cut out the series winding, the motor will overspeed with a heavy load in the car in the down motion. It may also overspeed in the up motion with no load in the car on account of the overcounterweight.

A case in mind of overspeeding of an elevator is that where the series-field winding of the motor was cut out in two steps. When the motor was connected up, a mistake was made and one section of the series winding was connected in so that it had the wrong polarity. This left the series winding so that it was practically ineffective during starting, since the effect of one section neutralized that of the other. As it happened the section connected correctly was cut out first and the section connected in wrong was cut out last. One day the elevator started to overspeed in the up direction and then the wrong connection of the series-field coils was discovered. The cause of the overspeeding was found to be due to the controller functioning so that only half of the series-field winding was cut out. As the section of the series winding in circuit was connected wrong, the motor was running with one-half of the series winding opposing the shunt winding, which weakened the field and increased the motor's speed.

In the down direction with a heavy load in the car, if the armature resistance is not cut out of circuit, there will be a tendency to overspeed. On account of the added resistance in the armature circuit, the motor operating as a generator has to run at an increased speed to set up the necessary braking current to arrest the motion of the car. On some of the old hand-rope controlled elevators, it was possible for the operator to release the brake without connecting the motor and controller into circuit. Under such a condition the elevator would be likely to overspeed if released with a load in the car.

Open-circuits or short-circuits in the shunt-field windings will also cause excessive speed, but the conditions will generally cause blowing of the fuses, when the series-field winding is cut out of circuit. One case in mind of an elevator with a hand-rope control, the shunt-field coils were open-circuited, but the operator manipulated the control so as not to cut out the series winding and ran the elevator with the motor operating as a series machine. Needless to say, the machine operated at an excessive speed.

Shifting the brushes back of the neutral will cause an increase in speed. On a reversing motor, if the brushes are back of the neutral for one direction of rotation, they will be ahead of the neutral in the other direction of rotation. Therefore if the brushes are shifted accidentally or otherwise off the neutral of an elevator motor, it will result in increased speed in one direction of motion of the car and reduced speed in the other. If the brushes are shifted very far, severe sparking will result, which may cause flashing over on the commutator and the fuses or circuit breaker to open.

Other faults in the motor that would cause the fuse to blow are: Short-circuit of a number of coils in the armature; open-circuits in the armature, where they produce sparking severe enough to cause flashing over on the commutator; open-circuit in the shunt-field coils; short-circuit between the shunt- and series-field coils; grounds in the field coils or armature windings. In some cases the brushes may start to chatter and cause a flashover on the commutator, resulting in the fuses blowing. On motors of 10- or 15-hp. rating such a flashover may not leave much of an indication on the commutator of what happened. If such occurrences are only intermittent and no one happens to be near the machine when the flashover occurs, the cause of the fuses blowing may be difficult to locate. In one case a 10-hp. 220-volt motor had been blowing the fuse at irregular intervals of a few days for several months before the cause, flashing over on the commutator, was discovered. In no case was a mark left on the commutator or brushes and holders that would indicate that the fault was in this part of the machine. The fault was located by a guess on the part of the maintenance man, that when the armature rotated against the brushes, they might at times chatter and cause a flashover. A little experimenting soon showed that this did happen, and the cause was eliminated by properly adjusting the brushes.

Another cause of the fuses blowing, is the series- and shunt-field windings connected so as to have wrong polarity. On account of the comparatively large number of turns used in the series winding of compound motors for elevator service, it will generally be impossible to put the motor into service with the field coils in opposition without causing excessive speed or blowing the fuses. However, if trouble is being experienced with a compound elevator motor, it will be advisable to check up the polarity of the field coils. Short-circuit between the shunt- and series-field coils, grounds in the field coils or armature windings will cause the fuses to blow. Other causes of fuses blowing have to do with faults in the controller and mechanical parts of the equipment, which will be discussed in the articles dealing with these details of the machine.

Causes of the motor failing to come up to speed are usually due to the controller failing to function properly, such as not cutting out the starting resistance, brake not releasing, etc., and will be discussed in a future article. The armature rubbing on the pole-pieces, due either to worn bearings or to a loose polepiece, would cause a reduction in speed. A short-circuit of a number of coils in the armature is also another cause of the motor failing to come up to speed. Any of these causes will generally be accompanied by excessive heating.

Noisy operation of the motor is generally due to mechanical faults such as the motor not in line with the wormshaft, armature out of balance, loose parts, armature striking the polepieces, rough commutator or chattering of the brushes. A common cause of noisy operation is the motor out of line with the wormshaft. It is necessary that the motor be carefully lined up, not alone to eliminate noisy operation, but also to prevent breaking the armature shaft at the brake-wheel coupling. In alternating-current motors conditions in the power system affect the quietness of the motor's operation. This will be discussed in the following article, which will deal with faults in alternating-current power supply and motors.

Meeting Foreign Competition

THE possibilities of foreign competition in the domestic market for power-plant equipment are strikingly illustrated by several instances that have lately come to light. In two of these cases the bids for major equipment delivered, including duty and freight, were little more than two-thirds that of the lowest American bidder, and the guaranteed performance was comparable to the best of the domestic terms.

When the handicaps of tariff and freight are considered, it is evident that there must be a wide difference in production costs. This, presumably is due largely to the higher wages paid the American worker, for in this class of production labor is a large factor.

Experience has shown that in practically all lines susceptible to quantity production and standardization, American manufacturers have been able successfully to invade and dominate the foreign field in spite of our higher wage standard. Of course, major power-plant equipment, for the most part, must be built rather than manufactured, and there is little chance for quantity production. There are, however, almost unlimited opportunities to apply greater standardization, which would reflect in a material reduction in production cost. Here is one way in which foreign competition can be met with comparative ease before it has become serious.

The purchaser, in his desire to carry out personal tastes or in an effort to secure increased economy, is probably most to blame for the great lack of standardization, although the manufacturer cannot escape some responsibility. When one stops to consider the average relation between fixed charges and total generating costs, it is apparent that some are "saving at the spigot and wasting at the bung."

Simplified Practice Needed

BRUSHES used on the commutators or slip-rings of electrical machines may look like an inconsequential part of the machine, but they represent a great deal of careful investigation to bring them to their present high quality, and it requires an industry of considerable magnitude to supply the requirements. The design of electric power equipment has passed through vast changes, and with the changes have come demands for an ever-increasing variety of carbon brushes.

As an illustration of this, in the automobile industry alone, there are about 2,400 different shapes and sizes. In this industry there is only a small variation in the size of the electrical units, and they are for what might be considered a standard application. In the general power field, with its wide diversity of equipment and application, conditions must be even worse than they are in the automobile field, and this emphasizes the necessity for attempting to do something to reduce the number of sizes of brushes in use.

The efforts now being initiated by the brush manufacturers in co-operation with the Division of Simplified Practice of the United States Department of Commerce deserves the hearty support of the whole electrical industry. In some forty-five industries that have adopted the simplified practice, fostered by the Department of Commerce, reduction in sizes and types have been obtained ranging from thirty to ninety-eight per cent. Taking the lowest of these figures and applying it to the brush industry would offer a measure of relief well-worth considering.

Let the Decision Be an Economical One

NOT so long ago, if a building of any importance was constructed, it was the general practice to install a power plant in it, to supply the power and heating requirements. This was done whether power could be purchased or not. If power was purchased later, the investment in the plant was considered by the owner to be justified, as he felt that it helped him to obtain a more satisfactory rate from the power company and to retain this rate after shutting his plant down. As a result of this attitude many plants were installed that probably should never have been.

Rates for power are now fixed by public service commissions, therefore the use of a power plant to control them has disappeared and with this has apparently vanished any desire by the average business man to have anything to do with power-generating equipment. Where low-pressure steam is needed for heating during the winter months only and the power requirements are small, it is well established that purchased power is the most economical. Under these conditions the management of the building or business is also relieved of responsibility.

When it comes to an enterprise requiring low-pressure steam throughout the year for process work in conjunction with large power requirements and in addition to this to operate a refrigerating plant and a large amount of other equipment such as found in many plants, the problem takes on an entirely different aspect. Whether power is purchased or not, the management still has a large responsibility in the heating and power equipment in the building and the whole question should be considered from the economic point of view only. The one way to be relieved of power-plant responsibility in this case is to put a high-grade engineer in charge and give him the responsibility. With such a man the power-generating equipment will probably be the least of his worries, and if a survey indicates that he can generate the power cheaper than it can be purchased, the economical thing to do will be to install the generating equipment.

With all the improvements that have been made in the large steam-electric power station, an over-all ther-

mal efficiency of twenty per cent is about the best that can be maintained in present practice. With a combined heating and power load an over-all thermal efficiency of sixty per cent may be obtained. In the latter case the power is produced near the job, whereas in the former it must be transmitted through an expensive transmission and distribution system where another loss is incurred. There is no rule of thumb to determine whether it is cheaper to purchase power or generate it, each installation requires careful study by competent and unbiased engineers and a decision should be reached on economic considerations and not by anyone's pet hunch or hobby.

What Is Economizer Efficiency?

ON PAGE 545 of this issue appear some new "Operating Code" definitions submitted for the comments of the engineering fraternity in a recently issued report of the N. E. L. A. Prime Movers Committee. Among these suggested definitions is the following:

Economizer Efficiency is the ratio of temperature rise of the water to the difference between the inlet-gas and the inlet-water temperature of an economizer. Note: With constant water velocity the temperature rise is proportional to the difference between the inlet-gas and the inlet-water temperature. The ratio of temperature rise to the difference between inlet-gas and inlet-water temperatures is the measure of economizer efficiency that is independent of variations in inlet-water and inlet-gas temperatures under the conditions stated. The only other factors affecting heat transfer appreciably are the quantity of water flow and the ratio of weight of water to weight of gas flowing. Since the weight of gas flow and water flow are nearly proportional and since the heat-transfer coefficient on either side of the tube varies almost directly with the velocity of the medium with which it is in contact, the temperature rise of the water per degree difference between inlet-gas and inlet-water temperature is a quantity which varies little with the boiler rating.

The reasoning of the foregoing note is substantially correct. Moreover, the ratio covered by this definition should certainly be of great value to the operating man, since it would require only the simplest measurements and computations. Yet serious objection may be raised to the term "economizer efficiency" as applied to this ratio. The term "efficiency," as used by engineers, has a wide variety of applications, but practically all of them simmer down to the ratio of output to input. Now it is clear that the proposed economizer "efficiency" is not the ratio of an output to an input. Since, under typical operating conditions an economizer receives about two pounds of gas for each pound of feed water, the feed temperature could not ordinarily rise more than about halfway to the inlet-gas temperature, even in a perfect economizer where the water extracted from the gas the last bit of available heat, bringing its temperature down to that of the inlet water. In other words, even a theoretically perfect economizer could show only about 50 per cent efficiency on this basis.

Why not retain the suggested ratio for its practical value, but give it a new name, such as "economizer operating ratio" or "economizer temperature ratio," reserving the term "efficiency" for more legitimate uses. Presumably "economizer efficiency" would normally be taken as the ratio of the heat absorbed per hour by the water to that available per hour in the incoming gas, the available heat being that measured above the temperature of the inlet water.

The Joke on the Anthracite Industry

VARIOUS publicists have remarked with some wonder as well as chagrin that the country refuses to be upset over the anthracite coal strike. Steps are being taken by various agencies to stir up the interest of the public in the wage struggle between the miner and operator, stress being laid on the point that the country is vitally concerned in this labor war.

Instead of the apathetic attitude of the average citizen being a thing to be troubled over, it is most laudable, indicating that at last the country has come to realize that anthracite is by no means a necessity such as light, heat and food. For all practical purposes anthracite is properly classified as an unwarranted luxury that the power plant and home can well do without. As the affair is developing, the little joke of boosting coal prices that the miner and operator expected to play on the consumer is developing into a huge joke on the jokesters.

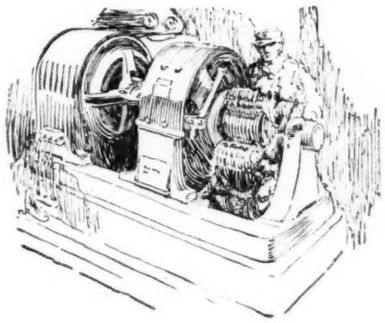
To solve the coal strike for all time to come, consumers need only refuse to buy it at any price. If bituminous coal, which can be purchased for less than the hard coal, be burned under boilers and such fuels as coke, charcoal, oil and the better grades of bituminous coal be ordered for the household furnace, the anthracite monopoly will cease to function in its customary high-handed manner and the present excessive tribute paid to coal-land owners will speedily shrink to a more proper value.

A tradition has been built up in the East that anthracite is a superior fuel and should be used to the exclusion of the more plebeian fuels, and the public has paid generously for its aristocratic tendencies. The fact is that anthracite is a poor fuel and carries two to three times the amount of foreign matter found in good bituminous coal. It is an expensive form of heat and its only claim is that of smokelessness.

Coke, on the basis of heat per ton, is superior, and its freedom from smoke is equal to the best of anthracite. The real drawback to the general use of coke is its price, which, while slightly higher than that of hard coal, is almost twice its value based on the costs of the raw coal and the processing. It is inexcusable for coke to cost sixteen dollars a ton when the coal from which it was produced costs only one-third of this amount. While many use anthracite in fireplaces, stoves and the like, charcoal is superior and, based on results, is as cheap as the former. Oil is becoming popular for use in small furnaces, but there, too, the distributor has taken advantage of the demand, boosting the price one hundred per cent over quotations of two years ago, even though crude oil has shown no advance. It does look as if the joke can be turned on the anthracite industry if other fuel producers do not grow rapacious.

Europe still leads in extreme pressures. Sulzer Brothers, of Winterthur, Switzerland, are at present engaged in the construction of a boiler to work under fifteen hundred pounds pressure, the steam to be used in a unaflow engine. The boiler is made up of two sections, a low-pressure and a high-pressure element. The high-pressure drum is made from a pierced forging, and all tube connections to headers and drum are placed outside of the boiler walls and away from all high-temperature zones.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for August will be announced this month.

Contraction and Expansion in Steel Structures

The two basic forces in mechanics are contraction and expansion. All known substances possess the characteristic to expand and contract under given temperature conditions. The designer of a structure is confronted with this inert movement of matter in practically every problem of design. He must devise means to compensate for it, to allow such movement freely and without excessive friction. A boiler shell, for example, must be provided with rollers on which one end may move during the play of these forces. A horizontal beam must be provided with means whereby one end at least may move longitudinally without increasing the internal stress either in the beam itself or in the abutment.

A novel means of taking care of expansion in the inclined-belt-conveyor structure was employed at the Riverside Station erected by the United Light & Power Engineering & Construction Co., near Davenport, Iowa, shown in Fig. 1. The conveyor connects the rotary coal breaker with the boiler plant proper. The coal is unloaded from dump-bottom cars into a track hopper. Here it is picked up by an inclined-belt conveyor and carried to the 250-ton per hour breaker located in the pent house. From this breaker the coal goes onto

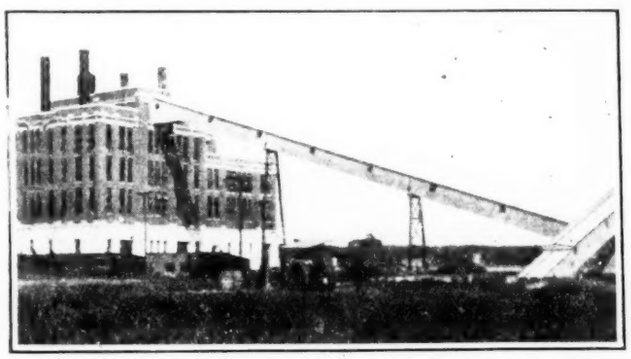


Fig. 1—Inclined-belt conveyor is supported between buildings by two hinged structural steel frames

another inclined conveyor and is carried to the boiler room, discharging at such a height that the coal delivers into a distributing conveyor. The angle this conveyor makes with the horizontal is about thirty degrees.

The conveyor structure is entirely steel girder construction and takes a bearing on the boiler-plant wall near the top, and the bottom end of this conveyor rests on the breaker house, which is also a steel structure. The conveyor leading to the track hopper comes off at right angles from the breaker house. Obviously, any

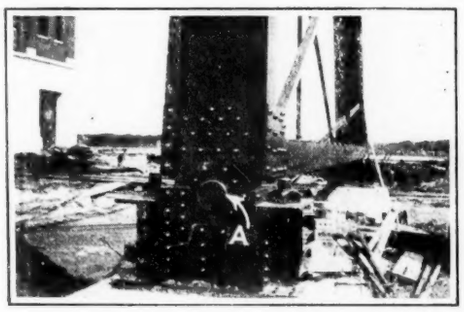


Fig. 2—Supporting frames are carried on 6-in. journals

lengthening or shortening movement of the inclined-conveyor structure will tend to tilt the breaker house or move the boiler-house wall inward. To prevent such a contingency, the conveyor structure is firmly anchored at the bottom or breaker-house end and the upper end is provided with limited movement, free, however, as possible within the limits.

The structure is further supported between the two buildings by two structural steel supports or A-frames, as shown in Fig. 1. The bottoms of these frames rest on steel and concrete foundations, and the connection between the support and the foundation is by means of 6-in. journals *A* illustrated in Fig. 2.

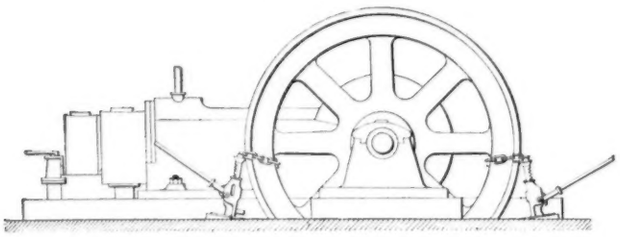
Rock Island, Ill. C. C. HERMAN.

Removing the Shells of Oil-Engine Bearings

According to a recent article in *Power*, oil-engine bearing shells can be removed by simply rolling them out of their housings. This probably refers to multi-cylinder engines, for it would be bad practice to roll the shell out of the center bearing of a one-cylinder engine, as the distance between the outer bearings would permit the weight of the flywheel to bend the shaft. For instance, the weight of the flywheel of a one-cylinder 100-hp. gas engine is 9 tons and the distance between the outer bearings is a little short of 11 ft. Lifting the flywheel is advisable, but a difficult job when an engine-room crane is not available or where

the construction of the building does not permit the erection of suitable rigging.

An easy way to lift a flywheel is shown in the illustration. Two suitable chains are wrapped around the rim of the wheel and serve as points of application for a couple of handjacks. When the bearing caps are removed and everything is clear, two men are required



Lifting a flywheel with handjacks

to handle the jacks, while a third one keeps the crankshaft level by inserting a tapered beam between the crank webs and the front part of the engine frame. A similar procedure may be followed when the engine is in course of erection. H. WIELAND LOS.

Schoonhoven, Holland.

Locating Trouble with the Indicator

The valves on the engine, from which the diagrams illustrated herewith were taken, had been set properly and the engine had operated for a short time. Evidence of something wrong appeared and the indicator was applied and the diagram Fig. 1 was obtained. In-

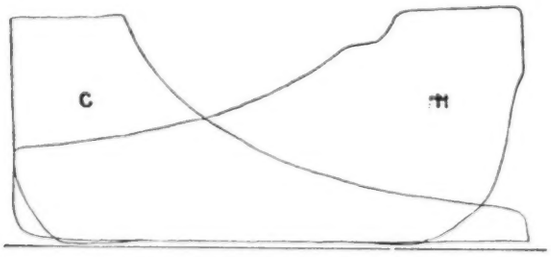


Fig. 1—Diagram showed steam valve on head end did not close properly

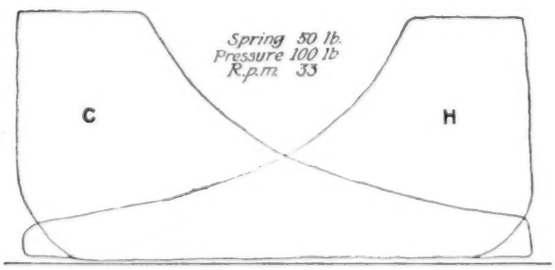


Fig. 2—Diagram obtained after adjusting dashpot rod

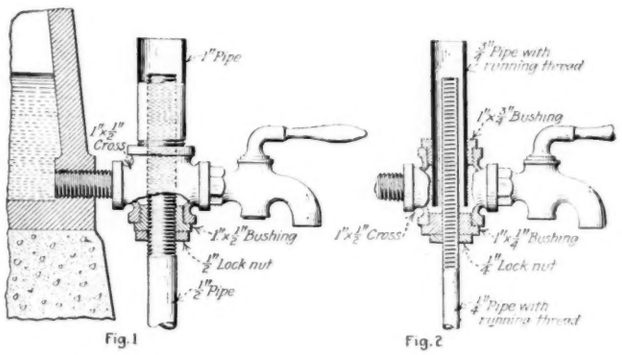
vestigation disclosed the fact that one of the dashpot rods had become loose and worked out sufficiently to prevent the valve from closing completely. Adjustment was made and the diagram Fig. 2 was the result.

The head-end diagram Fig. 1 indicates insufficient lead. This was also corrected. It pays to check up with the indicator occasionally. R. MCLAREN.

Toronto, Ont., Canada.

How Operation of Automatic Water Separator Was Improved

Some years ago the company with which I am now employed, installed three 16x16-in. inclosed engines, each being equipped with an automatic water separator as shown in Fig. 1. The action of these separators was



Original and improved construction of separator

not always satisfactory as considerable oil would pass over with the water.

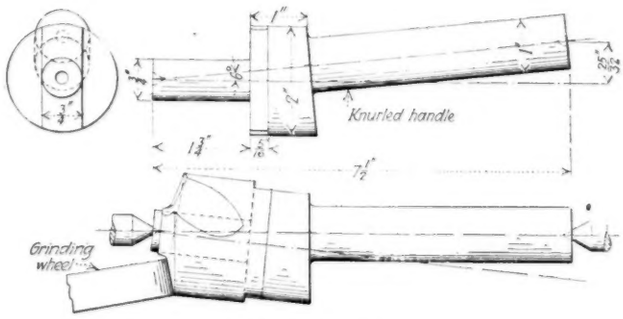
About six months ago we reconstructed them as shown in Fig. 2 and they work much better. The ¾-in. pipe was used in place of the 1-in. to give more clearance in the cross, and it was screwed down to within ¼ in. of the lower bushing to seal the opening from the engine. This arrangement prevents any oil passing over with the water. G. O. EBERHARDT.

Eau Claire, Wis.

Arbor for Grinding Counterbores and Tube Sheet Cutters

When grinding counterbores, flue sheet cutters, and other similar tools, it is essential that means be provided for holding them in correct position while the grinding is being done. The illustration shows an arbor we have designed for this purpose which takes the place of a special grinding machine. The arbor is made to the dimensions shown on the illustration.

In grinding the cutters, the arbor is placed on the



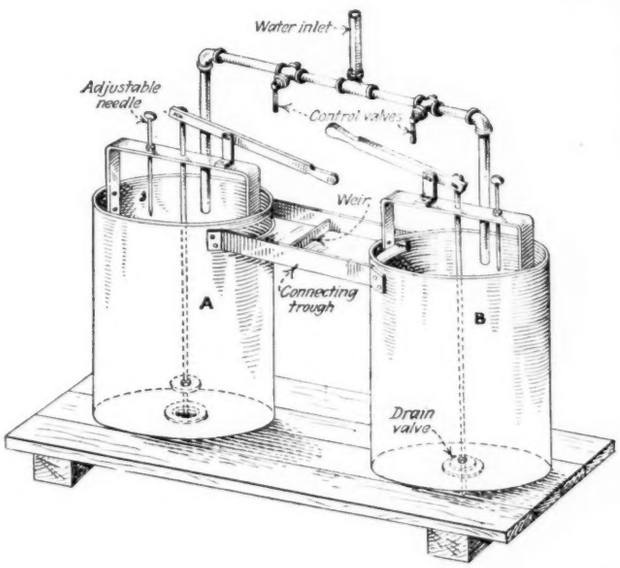
Detail of arbor

centers and turned back and forth slightly by hand until a good edge is secured. Then the cutter is turned half way around and the other cutting edge ground by turning the arbor back and forth slightly as before. This method of grinding has proved very satisfactory.

San Bernardino, Calif. J. WEIR.

Calibrating Feed-Water Meters in the Small Power Plant

Often in the smaller power houses no convenient means are provided for checking periodically the accuracy of the water meters. Many plants operate week after week with evaporation figures that are incorrect. In my opinion it is simply a waste of time to compare



Weir is used between tanks to insure a uniform level

pounds of water evaporated with pounds of coal burned when either or both of these values are only approximate. There is a satisfaction in knowing exactly the percentage of error in weighing apparatus—to say nothing of the savings that may be effected when working on reliable figures.

The illustration shows a home-made device that we use for checking our water meters. The tanks hold about 500 lb. each and can be made from steel drums or barrels. The same arrangement can be used for weighing large quantities of water per hour, by using larger tanks. Large drain valves (6 to 8 in. diameter) are provided. The valves and seats are made of cast iron and are ground in for a tight joint.

The following accessories are used in operating the tanks: Control valves that allow full flow of water from the meter; drain valves with operating handles attached; a weir placed inside the trough that connects the two tanks, and adjustable needles that indicate the proper time and height at which to empty the tanks.

The drain valves have a large opening and discharge the water to the sewer, as the tests are usually held for a short period of time. The weir should be set level to get an even flow, while the adjustable needles are set to give a thin sheet of water over the weir at the instant the meniscus breaks at the point of the needle. By using the weir between the tanks, it tends to give a uniform level to each tank and at the same time provide a signal for the man operating the tank.

Now for the practical operation. First, the tank must be calibrated by means of an accurate platform scale. This can be done by filling tank *A* until water runs over the weir to tank *B*, when the bubble breaks at the adjustable needle, the tank is emptied and the water weighed in a barrel on a platform scale. This weight is recorded as a constant for the tank *A*. In the same way the weight for tank *B* is found.

Having found the weight of water held by each tank, we are ready for an actual test. With both drain valves closed, the control valve to tank *A* is first opened and the tank allowed to fill until water flows over the weir to the tank *B*. Next open the control valve to tank *B* and close the one to tank *A*. When the water level in tank *A* has become steady, by lowering to the level of the weir, the drain valve on tank *A* is opened and the tank allowed to drain as quickly as possible. Immediately the tank is empty, the valve should be closed for the next fill. The cycle is then repeated for the tank *B*. At the completion of the test the total water weighed is readily computed by multiplying the number of tanks recorded by the weight for each previously determined.

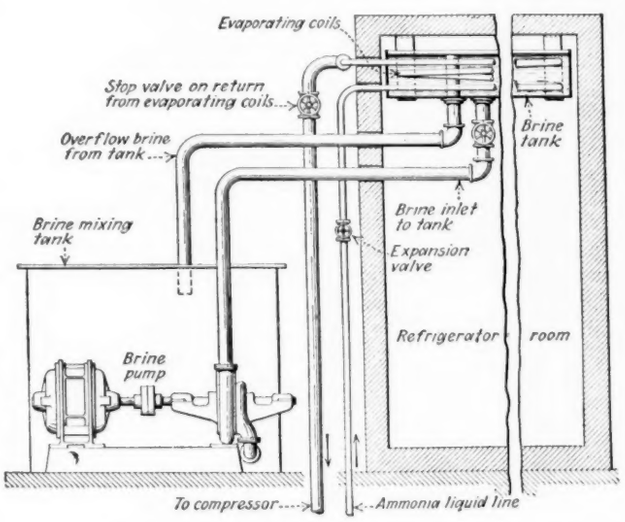
A. F. GRAVES.

Pittsfield, Mass.

Brine Tank for Cooling Coils

In most plants it is necessary to regularly defrost the evaporating coils or cooling coils of the refrigerator. At best it is a dirty and troublesome job and inconvenient to everyone concerned. I have an idea or a suggestion that might possibly remedy this trouble and would like to hear what other engineers might think of it.

Why not bend the cooling coils in such a manner that they can be completely submerged in a shallow flat tank attached to the storage-room ceiling and the tank filled with a strong solution of calcium-chloride brine, as shown in the illustration? This would prevent ice



Suggested cooling-coil arrangement

or frost from forming on the coils, the surface of the brine acting as the cooling medium. If one tank was insufficient to maintain the temperature, two tanks could be used, one above the other. The bottom or sheet-iron surface of the tanks could be insulated with cork or other material to prevent frost or ice from forming. Brine could be pumped into the tanks with a pump whenever they needed filling. One pump could supply any number of boxes, as it is not desired to circulate the brine.

R. L. TULLIS.

Monrovia, Calif.

Comments from Readers

Rotary Air Compressor

In reading the June 23 issue I noticed an article in the "New and Improved Equipment" section on a rotary air compressor. This brought to mind the old saying, "There is nothing new under the sun."

About the year 1887 there was manufactured by the Brazelle Governor Co., St. Louis, Mo., a throttling governor for steam engines, which consisted of two rotary pumps on the same shaft and in the same casing. These pumps discharged against a piston which was resisted by a spring. There was an adjustable bypass from the discharge to the suction side of the pumps. These pumps were as near like the rotary compressor described in the issue referred to as two peas out of the same pod.

About the same time there was used in the Illinois coal field a rotary air engine, which worked in much the same way as the new-type compressor. How often we find new inventions are really re-inventions.

Forty years have elapsed since the new idea was developed and the machines manufactured on a commercial scale with interchangeable parts and on a standard of workmanship that would compare favorably with that of today.

Mr. Brazelle was for several years connected with the Buckeye Engine Co., Salem, Ohio, and experimented with an engine that combined a throttling governor with a variable cutoff governor. As the speed of the engine increased, the cutoff was automatically shortened and at the same time the pressure in the steam chest was reduced by the throttling governor. The idea was to prevent the expansion curve falling below the atmosphere on light loads. Mr. Brazelle succeeded in working the idea practically, but it was not adopted commercially. Many steam plants of today which use automatic engines could improve the economy by carrying lower steam pressure during periods of light loads.

SAMUEL P. BAIRD.

Columbus, Ohio.

College Entrance Requirements for Engineering Students

I was greatly interested in the letter of David E. Davis in the Aug. 4 issue, on "College Entrance Requirements for Engineering Students."

While I do not feel that I am qualified to discuss the technical requirements for an engineering education, I believe that I am in a somewhat exceptional position to throw some light on the question he has raised as to the necessity for furnishing to students some reliable information as to the prospects and requirements in the engineering field.

During the last eighteen months I have interviewed over one hundred applicants for membership in one of our leading engineering societies, the majority of whom are under thirty years of age. I discussed with these young men their past experience and their ambitions for the future, and I have found that with few exceptions, upon leaving college, they drifted into the first reasonably remunerative opening available, without any reliable information as to their prospects or adaptability. Consequently many of them bid fair to spend the rest of their lives trying out other jobs that look more hopeful, chiefly, I suspect, because they have even less information about them than they have about their present one.

Now the point I would make is, that the men themselves are not chiefly responsible for this state of affairs. They are almost pathetically eager to get information from an older man, who they think may give them some useful advice and who is willing to show an interest in them. But the experience of one man is only limited, and his opinion may be unintentionally prejudiced, and when he looks for reliable data upon which to base a worth-while opinion, it is not available.

Our colleges are turning out men by the thousands with at least a preliminary technical education, and they do not know just what they are preparing their men for; at any rate I have yet to meet an engineering graduate to whom they have given the information.

I do not make this statement in order to criticize the colleges. Many educators no doubt do their best to advise their students, but they have no reliable data, and the best they can do is to discuss general principles, which do not help much when it comes to solving a definite practical problem.

The financial loss to the industries due to this state of affairs must be enormous, and the loss to the men themselves, not only in dollars and cents, but in unsatisfactory personal development, must be even greater.

Do not the most elementary considerations of efficiency indicate that, even before entering college, as Professor Davis suggests, but most certainly upon graduation, there should be available to these young men reliable and as far as possible complete data, upon which to base a decision as to their life's work?

To collect and present these data properly would cost money, and it should cost money—it is worth it; on the other hand, following Mr. Davis' idea, it is quite possible that the present disgraceful rate of "Infant mortality" in the freshman classes might be so reduced as to compensate for the entire cost of obtaining the necessary data.

Large sums of money are spent for technical education, but they cannot be efficiently spent unless the job is properly finished, and it cannot be properly finished unless we have definite knowledge as to the objective.

One of the main objectives is to equip the men to earn a living, but how is a man to use best his technical knowledge to make a living? Please do not ask this embarrassing question of the colleges, because they do not know, and I am convinced that it is up to the engineering profession to get the information for them.

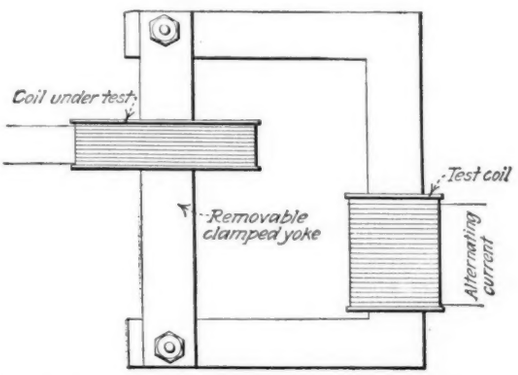
Newark, N. J. J. O. G. GIBBONS.

Locating Faults in Field Coils

With reference to the inquiry of W. H. K. in the Aug. 11 issue, as to the best way of testing field coils, the method shown here may be of interest.

Short-circuits in field coils may be tested by using alternating current to induce an electromotive force between turns. A method of applying the current is shown in the illustration, which is self explanatory.

Alternating current is applied to a test coil wound on a yoke which includes the coil to be tested, the latter being mounted on a removable section of the yoke. The magnetism in the yoke, set up by the alternating-current source, induces an electromotive force in the field coil under test the same as in an ordinary transformer. The total electromotive force induced in the field coil will, of course, depend on the total number of turns, or in other words, there will exist in the coil under test so many volts per turn. Should there be any short-circuited turns in the field coil under test, there will be evidence of it by smoking or heating up. This is a test used by manufacturers of electrical machinery as a routine matter. It is applied in a modified form to armatures when completely wound. The equipment for making a test of this kind is found in up-to-date electrical repair shops, and the test coil is wound with taps to permit of suitable variation for the different types of coils to be tested.



Method of testing field coils with alternating current

Springdale, Pa. G. OTTO VON DANNENBERG.

How the Water Hammer in the Exhaust Header Was Eliminated

The letter of W. H. Collins in the July 7 issue presents a rather interesting problem, and a study of the article would seem to indicate that a technical explanation would be in order.

As originally connected, the condensate tank had but a single opening into the exhaust header and the condensate in the header would not drain into the tank. If pressure gages had been connected to the exhaust header and the condensate tank, it would have been found that the pressure in the tank was somewhat lower than that in the exhaust header. The factor that produced this pressure difference was responsible for preventing the drainage of the condensate into the tank. It is a characteristic of any fluid in motion to entrain and carry with it fluids brought in contact with the main current, which action is sometimes spoken of as "siphoning action."

The exhaust steam, which is presumably traveling at a fairly high velocity in the header, passed over the opening into the condensate tank and instead of flowing into the tank tended to draw the air from the tank and carry it along through the header as indicated in Fig. 1. This action lowered the pressure in the tank. The natural assumption would be that condensate would flow into the tank so as to equalize the pressure, but this was prevented by the velocity of the exhaust steam and by the siphoning effect produced.

When the equalizing line was established so that the condensate tank was connected above the elbow in the pipe line, the siphoning effect at one opening tended to equalize the siphoning effect at the other, with the result that there was a flow of steam through the tank

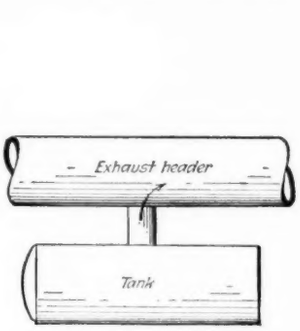


Fig. 1—Diagram of original connection to condensate tank

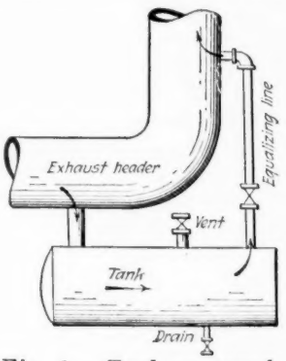


Fig. 2—Tank arranged with equalizing connection

as indicated by the arrows in Fig. 2. Owing to the difference in the location of the openings, however, there was in all probability a slight differential of pressure established, which contributed to the flow of steam through the tank. With a current of steam at low velocity passing through the tank, it was possible for the condensate to enter through the original drain pipe and collect in the tank, while the accumulated steam escaped through the equalizing line.

If the valves in the equalizing line and sewer line are closed and the vent slightly opened, it will be found that a considerable suction will occur at the vent.

Scranton, Pa. R. B. SMITH.

Generated or Purchased Power in the Paper Mill

The statements of central-station power salesmen are often accepted even when no actual proof is presented. For instance, a plant having a 500-hp. single-cylinder condensing engine and three 100-hp. engines driving paper machines, was urged to change over to central-station service on the ground that the average isolated plant used from 4 to 6 lb. of coal per kilowatt-hour while the central station generated the same unit of energy from 1½ lb. of coal. The plant in question developed 625 hp., of which the main engine furnished 400 hp. and the paper-machine engines 75 hp. each. This was equivalent to 480 kw., and they burned 2,500 lb. of coal per hour. If we merely divide the hourly fuel consumption by the kilowatt-hours generated, then apparently the engines use over 5.2 lb. of coal per kilowatt-hour, and if coal costs $7 per ton the central-station advocates insist that the fuel cost alone is 1.82c. per kilowatt-hour. If the central station makes

an offer to furnish power for 1¾c. per kilowatt-hour, the management often assumes that they will save the difference between 1.82 and 1¾c. per kilowatt-hour plus the wages of two operating engineers and the wages of half the boiler-room crew. The power salesman glibly states that this saving will exceed $10,000 a year and frequently a five- or ten-year contract is signed.

But let us make a thorough analysis of the power cost in a plant of this type. In the machine room the exhaust of the paper-machine engines is all used in the driers and in addition considerable live steam is used, being reduced in pressure from 125 to 10 lb. These engines are of the slide-valve, throttling-governor type and their water rate is estimated to be 48 lb. per horsepower-hour at 10 lb. back pressure. If the entering steam is dry saturated at 125 lb. pressure, it contains 1,192 B.t.u. per pound and the exhaust contains 1,160 B.t.u. per pound. With a 48-lb. water rate only 53 B.t.u. $\left(\frac{2,546}{48}\right)$ are extracted from each pound of steam passing through these engines and the exhaust will contain about 5.5 per cent condensation.

To generate a pound of steam at 125 lb. pressure from feed water at 212 deg. F., requires 1,012 B.t.u., and only 53 B.t.u. or about 5¼ per cent of this heat, is utilized by the engine, the remainder going to the drying process. Therefore the heat that is in the exhaust steam should be charged against the drying process and not against power generation. Of course, if no power was generated the boilers would operate at lower pressure, which would mean lower flue-gas temperatures. But even after making due allowance for this, not over 10 per cent of the heat put into the steam at 125 lb. pressure (1,012 B.t.u.) should be charged against the engine. The remaining 90 per cent, which is rejected in the engine exhaust and passes into the driers, must be charged to the driers. With an evaporation of 8 lb. of water per pound of coal the only fuel required to develop a horsepower-hour in the paper-machine engines is $\frac{48}{8} \times 10$ per cent $= 0.6$ lb. per hp.

The heat balance of these engines operating in connection with the driers, approaches 100 per cent, and few if any central stations can develop a horsepower-hour on 0.6 lb. of coal. How then can the central station effect any reduction in the power costs of this company by selling current to drive the paper machines, when they must generate this current with turbines whose best performance shows a greater fuel consumption than 0.6 lb. per horsepower-hour inasmuch as they have a condenser loss around 50 per cent? The fuel cost of the power generated by the paper-machine engines is thus proved to be 0.21c. per hp.-hr., or about 0.3c. per kw.-hr.

The water rate of the main engine is 18 lb. per horsepower-hour, and this corresponds to 2¼ lb. of coal per horsepower-hour, giving a fuel cost of $0.00795 per horsepower-hour and this is equivalent to a fraction over a cent per kilowatt-hour. The total load on the boilers is 20,000 lb. of steam per hour, and 12,000 lb. of this goes to the machine room, 7,200 to the main engine and 800 lb. to the boiler-feed pump and condenser pump.

The only steam chargeable to power generation is 7,200 + 800 + (10 per cent of 12,000), or 9,200 lb. The balance of 10,800 would have to be generated even if the engines were replaced by purchased current. Since this mill runs 24 hours a day, 300 days a year, the total horsepower-hours generated is 4,500,000. The total fuel chargeable to power costs is $\frac{9,200}{8} \times 300 \times 24 \times \frac{7}{2,000} = \$28,980$. Labor costs are $17,100 per year and are itemized as follows: One chief engineer, $2,500; two assistants, $2,000 each; three firemen, $1,800 each, and four boiler-room helpers, $1,300 each. This gives a cost of 1.024c. per horsepower-hour or about 1.333c. per kilowatt-hour.

Now in this locality 1¾c. per kilowatt-hour is the lowest rate anyone purchasing power has been able to get where the connected load is less than 500 kw. So if current were purchased at this figure, the annual bill for current would be $45,000. In addition to this there would still be a considerable labor cost. The labor item of $17,100 per year would be reduced only by the wages of two assistant engineers and three boiler-room helpers, so $9,200 must be added to the $45,000 to show the relative costs. This shows a cost of $54,200 with purchased power and only $46,080 for generating costs in the present steam plant. The boilers and engines were installed twenty years ago, and the investment charges would not be reduced any by shutting the engine down and one boiler. There is also another charge to be added to the estimated cost of purchased power in order to insure an accurate comparison. Three 100-hp. motors would have to be purchased to replace the paper-machine engines, and a motor of at least 400 hp. would be required to replace the main engine. The total installation cost of the electrical equipment would be at least $10,000, and figuring fixed charges at 12 per cent, the costs will be increased by $1,200 a year.

If the paper company wanted to invest $10,000, that amount spent in improving the steam plant would effect a marked reduction in the cost of generating power. For instance, a superheater could be installed to superheat the steam going to the main engine, and the steam consumption of that unit would be reduced 10 to 12 per cent. This means a fuel saving of 100 lb. of coal per hour after allowing for the heat used in superheating. The fuel bill is thus reduced by $2,520 per year. If $3,000 were spent to purchase hand stokers for the three 78-in. return-tubular boilers, a 10 per cent reduction in fuel consumption would be possible. The present grates are set 30 in. below the boiler shell, and when the hand stokers were being installed this distance could be increased to 48 in. and this increase in furnace volume coupled with the advantages of the hand stoker would insure at least 10 per cent saving, or approximately $4,725 a year, which would amortize the investment in eight months.

But in the average plant of this type seldom is any attempt made to analyze the power costs thoroughly and charge the correct proportion of fuel and labor to power generation. If it were possible to operate for a trial period of 30 days with central-station power before signing a contract, the case would soon be viewed in the correct light. But this course is impossible, hence the only method of arriving at a correct decision is to determine as closely as possible beforehand, how much fuel and labor will be required to supply the process steam demand. If the saving in fuel and labor costs is less than the electric power bill plus the capital charges on the investment in electrical equipment, obviously there will be a net loss if current is purchased.

Holyoke, Mass. ANDREW F. SHEEHAN.

Questions and Answers

Conducted by

Franklin Van Winkle

Height of Gage Cocks of 72 in. H.r.t. Boilers

For a 72-in. diameter horizontal return-tubular boiler, what should be the height above the tubes for the lowest water gage cock and the distance between levels of gage cocks? *E. L.*

The lowest gage cock should be set not less than 3½ in. above the top row of tubes, and this height should be regarded as the lowest safe water level. For a 72-in. shell the distance between levels of gage cocks should be 4 to 5 inches.

Identifying Type of Closed Feed-Water Heater

How may it be known whether a closed feed-water heater has steam inside or outside of the tubes? *J. B.*

When a heater is in operation and the steam is outside of the tubes, one part of the shell will be as warm as another part. If the steam is inside and water outside, the shell will be warmer at the top than at the bottom; also when the water is outside of the tubes, the water-supply inlet is in or near the bottom of the shell and the hot-water discharge connection is taken out of or near the top of, the shell.

Equalizing Leads of Corliss Engine

If on a Corliss engine the lead on the head end is correct, how can the same lead be obtained for the crank end without turning the engine over? *M. S. L.*

Since for the same leads the steam valves must have the same laps, disconnect the hook rod from the wristplate; place the wrist in the central position and adjust the crank-end valve rod to obtain the same lap for the crank-end valve as the head-end valve. If both valves have the same amount of lap when the wristplate is in the central position, and the lengths of hook rod and eccentric rod are such that the wristplate swings as much to one side of the central mark on the hub as the other, the leads will be the same.

Locating Valve Leakage

How can valve leakage of a non-condensing engine be located? *R. N. E.*

Place the engine on the crank-end dead center and block the crosshead to prevent the engine from turning over. If there is a single D slide valve, place the valve so it will cover the steam admission ports and open the throttle valve a little. Leakage of the valve then will be shown by escape of steam from open cylinder drain-cocks, open indicator connections, or from the exhaust pipe.

With a four-valve engine, leakage of either steam valve usually can be determined by opening the throttle a little when both steam valves are closed and observing whether steam escapes from the open cylinder drain-cock or indicator connection of the end under consideration, when the exhaust valve of the same end is closed while the exhaust valve of the other end is open.

The exhaust valves can be tested by admitting steam to the end of the cylinder which is under consideration, and opening the drain or indicator connection of the other end with both exhaust valves closed and noting whether steam escapes from the exhaust pipe. If it is found that at the same time there is escape of steam from the drain or indicator connection of the other end when the steam valve of the other end is tight, that would be an indication of piston leakage which would affect such tests of the exhaust valves. To cover interference from piston leakage, make tests of the head-end steam valve and both valves of the crank end with the cylinder head removed, and test the tightness of the head-end exhaust valve with the cylinder head in place, when the crank end of the cylinder is relieved of steam from piston leakage as far as possible by removal of the piston-rod packing and widest possible opening of drain and indicator connections on the crank end.

Brine Freezes at a High Temperature

In adding calcium chloride to our brine tank, by error a much larger amount of the salt was added than had been the custom. Upon putting the tank in commission, the brine froze, although the temperature was not below 0 deg. F. The gravity proved to be 36.5 Baumé. As the brine originally used had a gravity of 35 deg. and did not freeze even at a temperature of 20 deg. F., how is it explained why the heavier brine froze at a higher temperature? *G. L. B.*

As the density of brine, that is, as the percentage of salt in the solution increases, the freezing point lowers. This rule applies as long as the salt percentage is less than 30 per cent, or the solution has a gravity of 34 deg. Baumé. If the percentage of salt was increased above 30 per cent, the freezing point of the solution rises. Consequently, with the 36.5 Baumé solution you can expect a freezing temperature of approximately 2 deg. F. The freezing temperature curve reaches its lowest value when 30 per cent of the solution is salt and for greater percentage the freezing temperature rises.

Excessive Stresses from Hydrostatic Pressure Tests

Does a hydrostatic test of a water-tube boiler place any more stress on the boiler material than steam at the same pressure with normal water level? *E. P. C.*

The same stresses on part of the boiler result from the same static or standing pressure per square inch, whether from water, steam or air, of course allowing that when the boiler is filled with water there will be

greater pressure in the lowest parts of the boiler due to the weight of a greater depth of water. But in undertaking to subject a boiler to a given hydrostatic test pressure, the intended test pressure is exceeded by the last strokes of the testing pump even when the test pressure is approached very gradually. The stresses resulting from the final application of pressure is indeterminate and for the same reasons that it is impossible to estimate pressure resulting from impact. How much the hydrostatic pressure may exceed the intended test pressure depends on the suddenness of application, but it probably results in no more serious stresses of the boiler material than the intensity of steam pressure shown by the reading that corresponds with the flick of the ordinary test gage which, as is well known, varies with the method of using the test pump.

Strong Exhaust of Pump from Leakage of Steam Valve

We have a new direct duplex steam pump in which the valves are correctly set, but there is a strong exhaust on one side for the entire length of the stroke. What may be the cause and remedy? *E. C. R.*

A direct duplex steam pump should have the exhaust open from the beginning of an exhaust stroke up to the time compression begins near the end of the exhaust stroke. If the piston does not cover the exhaust port tight from the beginning of compression, then there will be little or no cushion and the steam end of the pump will knock at the end of the exhaust stroke. If the steam valve and piston are both tight, the exhaust will be stronger in the beginning than at the end of the exhaust stroke.

If the steam piston packing leaks badly, the exhaust may be nearly as strong toward the end as in the beginning of an exhaust stroke; or if the steam valve leaks straight across to the exhaust, the exhaust pipe would show a strong exhaust during the whole stroke. If there is no pounding at the end of the exhaust stroke, it would appear that the trouble is from leakage of the steam valve across to the exhaust. Uncover the steam chest and inspect the condition of the steam valve and seat, especially of that side of the pump and on that end of the valve which should open to live steam for the reverse stroke of the one that appears to have too strong an exhaust.

Adjusting Corliss Dashpot Rods

How are the dashpot rods adjusted on a Corliss engine? *T. P.*

When the steam-valve rods have been set to their proper length for giving the valves the desired amount of lap when the wristplate is in central position, unhook the steam valves from the dashpots, allowing the dashpot plungers to drop home, driving them down with a block of wood to make sure; then carefully throw the wristplate over to its extreme travel and adjust the length of the dashpot rod so there will be an equal space between the hook block and latch steel on one side, and the hook block and the closing shoulder on the other side.

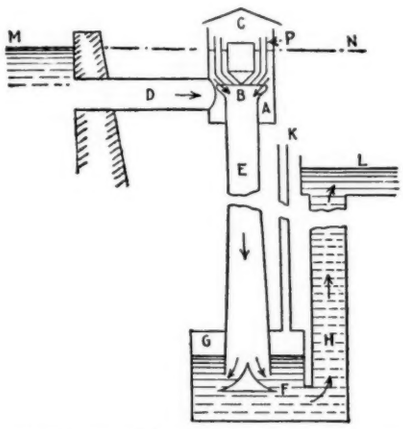
Serve the other end of the valve gear in the same manner, and then verify these adjustments by hooking up both valves and releasing them several times by swinging the wristplate its extreme travel on each side of the central position.

Adjustment of the dashpot rods should be made with care, for if incorrectly made, either the valves will not hook up or some part of the valve gear will be bent or broken at the first revolution of the engine. If the rods are left too long, the closing shoulder on the releasing gear will bring up against the hook block before the wristplate has reached its extreme point of travel and either buckle the dashpot rod or break off the valve crank. Too much air cushion will permit the plunger to drop only partly home. The remedy is to regulate the amount of cushion so the plunger will drop home rapidly but without pound or jar.

Hydraulic Air Compressors

What is the method of operation of hydraulic air compressors in which air is compressed by means of falling water? *W. B. L.*

The fundamental principle is the same as that employed in the trompe or water bellows, which is one of the oldest devices for compressing air. Water was led from a higher to a lower level through a pipe or bamboo pole, with openings in the side through which air entered and mingled with the descending water, from which the air was trapped under sufficient pressure for use in forges. Many improvements have been made on this early apparatus for delivery of the air at considerably higher pressures. One of these, the Taylor compressor, is shown diagrammatically in the figure.



Taylor type of hydraulic air compressor

A series of small air pipes *P*, placed vertically in the upper part of a receiving tank *AC*, have their lower ends terminated at the conical entrance *B* to the down-flow pipe *E*. A water supply *M*, at the level *MN*, is furnished to the down-flow pipe through a flume *D*. As the water falls, it draws air through the small tubes *P* carrying the water down to the separating tank *G*, where, from enlargement of the lower end of the down-flow pipe and deflector *F*, there is a sudden change in velocity of the water, with liberation of the air bubbles to the upper part of the separating tank *G*, where it is gathered at a pressure depending on the height of water in the vertical pipe *H*, through which the water is discharged upward to the tailrace *L*. The compressed air is then conducted through a pipe *K* to the place where it is to be used. The vertical distance from *MN* to the level of the tailrace *L*, represents the height or fall of water that is available for obtaining suitable velocity and for performing the work of compression and overcoming friction of flow.

New and Improved Equipment

Superior Oil Burner with Automatic Control

A type of steam-atomizing oil burner in which the burner and regulator for automatically controlling the amount of oil and steam are combined in one unit is a recent development of the Superior Oil Burner Co., 710 North Main St., Los Angeles, Calif.

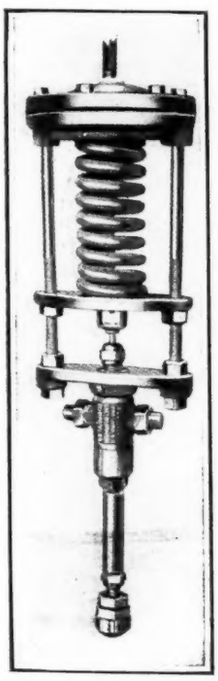


Fig. 1—Assembly of regulator and burner

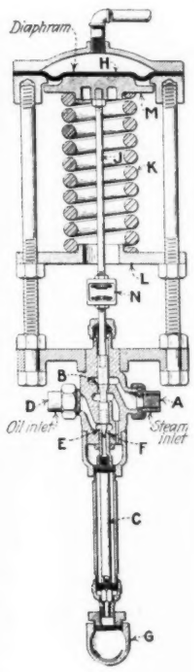


Fig. 2—Cross-section of regulator and burner

Referring to Fig. 2, the steam enters at *A* and expands through valve *B*, thence down around the outside of the stem *C*. The oil enters at *D* and the amount is controlled through the needle valve *E*. The seat *F* of this valve is adjustable to suit any grade or viscosity of fuel. After passing through this valve, the oil is led down through the stem *C* to the tip *G*.

The automatic regulation of the oil and steam supply is obtained through a diaphragm *H* acting directly on the stem *J* to which the valve stems *B* and *E* are attached. Opposing the steam pressure, acting on the top of this diaphragm, is the spring *K*, adjustment of which is readily accomplished by moving the plate *L* up or down to suit the various steam pressures. To facilitate close adjustment of the valve stems in relation to the upper spring plate *M*, which is moved up and down by the variation in the steam pressure, the coupling *N* is provided as shown in Fig. 2.

In addition to the automatic burner just described, a burner of the hand-controlled type has also been developed. This burner is essentially the same as the one described except that the openings through the valves *B* and *E* are controlled by hand instead of by a regulator.

Brown Recording Pyrometer

A recording pyrometer in which have been embodied a number of special features has been brought out recently by the Brown Instrument Co., Philadelphia, Pa.

The instrument is built to make a single record, a duplex record with two records side by side, or in multiple form to produce as many as 12 records on one chart.

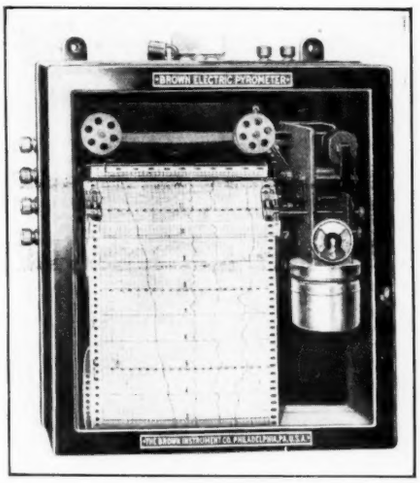


Fig. 1—Front view of pyrometer

It operates on the principle, in which a pointer swings freely and at intervals of every thirty seconds is depressed, inked ribbon producing a mark on the chart. The marks are sufficiently close together to form a continuous line.

The marking ribbon is above the paper so that the mark is produced on the front side of the paper. In the single and duplex types the ribbon is moved back after each mark, disclosing the last impression, so that the record is clearly visible immediately after it is produced. A glass knife-edge is furnished for tearing off the paper and is located directly below the driving roll. The paper can be torn off two hours after the last impression is made. A platen is supplied on which notes can be recorded on the chart with pen or pencil.

In addition to recording the temperature on the chart, an indicating scale is provided with large figures legible at a considerable distance. The chart has rectangular co-ordinates, the time lines being straight across the chart and not curved.

The recorder is driven by an electric clock if alternating current is available, the current consumed being about four watts. Where alternating current is not available, a hand-wound clock can be supplied.

The chart speed can readily be changed and is supplied for a number of combinations. The standard chart speed is 1 in. an hour, but by reversing two gears a speed of 4 in. an hour is obtainable. Speed combinations are available from ¼ to 6 in. an hour.

Automatic cold-junction compensation is incorporated in the instrument with an index for adjusting a compensated pyrometer to the correct initial starting point on open circuit. As a multiple recorder the instrument incorporates an automatic switch with gold contacts mounted on bakelite and immersed in oil, which prevents tarnishing of the contacts from corrosive gases in the atmosphere.

The multiple recorder switch includes a dial with index for indicating the number of the thermocouple or furnace which is being recorded at the time. The record lines are made in different color combinations on the chart and the switch dial is numbered and colored to correspond. The instrument is inclosed in a black enameled aluminum case, the dimensions of which are 15 in. high, 14 in. wide and 9 in. deep.

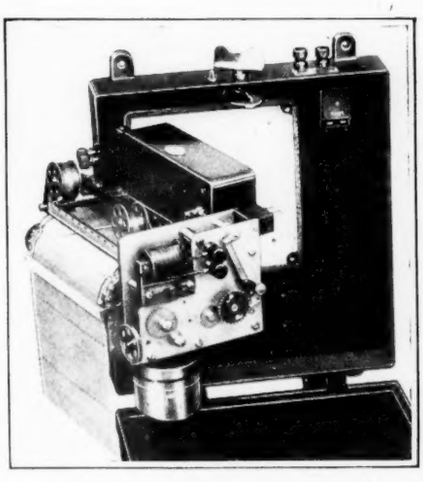


Fig. 2—Recording mechanism is carried on a hinged frame

Barrett-Haentjens Priming Pump

To meet the demand for a priming pump particularly adapted for priming the smaller sizes of centrifugal pumps,

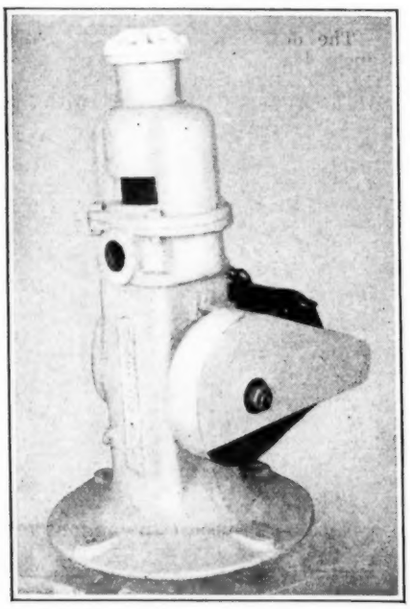


Fig. 1—Pump equipped with motor drive

Barrett-Haentjens & Co., Hazleton, Pa., have recently added to their line the type shown in the illustration. The pump is of the dry-air type and is used

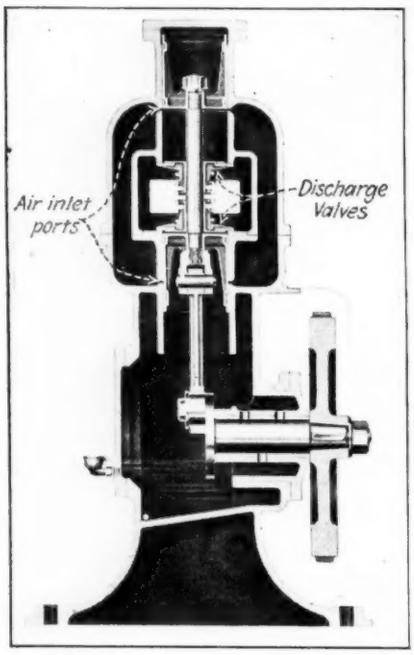


Fig. 2—Cross-section of pump

in conjunction with a vacuum breaker which prevents water from entering the pump.

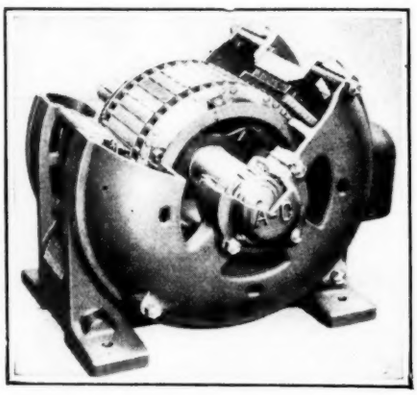
Referring to Fig. 1, it will be seen that the device is compact in design, the motor for driving being mounted directly on the side of the pump and connected to the shaft through a chain drive.

A feature of the pump is the method used of admitting air to the cylinder. No inlet valves are used, but instead the air enters the pump through narrow ports which are alternately covered and uncovered by the piston. The discharge valves are placed at the cylinder ends and seated by a single spring, as shown in the section, Fig. 2.

Allis-Chalmers Roller-Bearing Motors

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has recently brought out a line of 25- and 60-cycle motors especially designed for hard service, such as encountered in driving crushers, grinders and similar services.

The motors are built in the squirrel-cage and slip-ring induction types and are equipped with Timken tapered roller bearings arranged for grease lubrication, which tends to lessen the attention required. The bearings are



View of motor with roller bearings

mounted in the housing with a light press fit for both the cone and cup, no locknuts being used to hold the races in place.

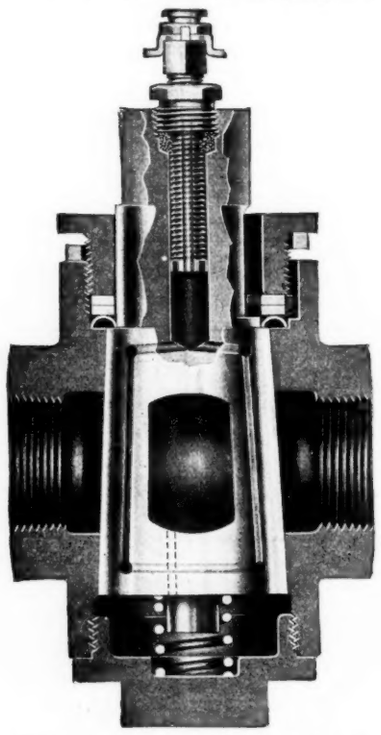
The frame of the motors is made of steel with feet cast integral. The openings in the housing and frames for ventilation are placed in vertical plane to prevent falling objects entering the motor. By employing roller bearings the length of the motor has been considerably reduced over that required for a sleeve-bearing machine.

This new line of motors includes all ratings up to 200 horsepower.

Barco Lubricated Plug Valves

A new line of all-metal, lubricated plug valves, made to withstand severe service, high temperatures, high pressures and difficult gases or fluids, has been designed by the Barco Manufacturing Co., 1801 Winnemac Ave., Chicago. A number of types have been perfected for all classes of service to withstand pressures from steam and air or oil gases up to 500 lb., hydraulic pressures not exceeding 1,500 lb., and temperatures not exceeding 1,100 deg. F.

As shown in the sectional view, the plug is seated in the body with the taper pointing toward the gland, so that it cannot blow out if the gland is removed. An important feature from the leakage standpoint is that the valve is tightened by pressure and when there is no pressure, contact between the plug and the body is assured by means of a spiral spring under the plug. Proper relationship between the plug and the body is maintained by the means indicated in the illustration; that is, a shoulder on the plug is machined line in line with a shoulder on the body, and a semispherical gasket made of alloy steel is in contact with both shoulders. Above the gasket is an adjusting gland with a spacing washer and also a stop washer to insure against the plug mak-



Sectional view of Barco lubricated plug valve

ing more than a quarter turn or such part of it as the operator desires.

When the valve is assembled, the gland is screwed down far enough to allow the plug to rest lightly on its seat. The lubricator screw is then turned until the seat of the plug and the body are thoroughly lubricated by a thin film of grease which prevents the contact surfaces from wearing.

As indicated, the lubricator consists of a stem traveling through a threaded bushing which is threaded into the top of the plug with packing underneath to prevent any grease from oozing out around the threads. In practice the stem is screwed out as far as the stop at the end will allow it to go. A lubricating gun filled with lubricant is then attached to the top, and the lubricating passages on the surface of the plug are filled with lubricant. These passages are closed against the loss of lubricant, either into the lower cavity or into the pipe line. Provision has been made for inserting lubricant by hand where no gun is available.

Standard Operating Definitions Proposed

AS IS natural in such a rapidly developing field, there is still some confusion in the use of terms descriptive of power-plant apparatus and practices, particularly the more recent developments. This matter has been under consideration for some time by a special subcommittee of the N.E.L.A. Prime Movers Committee which has just issued a brief extension of the Operating Code submitting the following additional tentative definitions[1] for the consideration of the profession.

Limiting Vacuum designates that value of vacuum at which the increase in turbine economy with increase in vacuum becomes zero.

Increment Efficiency is the efficiency of an increment in output.

Basic Station Efficiency is the calculated efficiency of the station, accounting for all those large losses which can be accurately calculated.

Expected Station Efficiency is the product of the *Basic Station Efficiency* and a factor which accounts only for small and unaccountable losses.

Operating Efficiency Factor is the ratio of *Expected* or *Obtained Station Efficiency* to *Basic Station Efficiency.*

Economizer Efficiency is the ratio of temperature rise of the water to the difference between the inlet gas and the inlet water temperature of an economizer.

Note: With constant water velocity the temperature rise is proportional to the difference between the inlet-gas and the inlet-water temperatures. The ratio of temperature rise to the difference between inlet-gas and inlet-water temperatures is a measure of economizer efficiency that is independent of variations in inlet-water and gas temperatures under the conditions stated.

The only other factors affecting heat transfer appreciably are the quantity of water flowing and ratio of weight of water to weight of gas flowing. Since the weights of gas flow and water flow are nearly proportional and since the heat-transfer coefficient on either side of the tube varies almost directly with the velocity of the medium with which it is in contact, the temperature rise of the water per degree difference between inlet-gas and inlet-water temperature is a quantity which varies little with boiler rating.

Boiler Unit consists of a boiler, together with its fuel-burning equipment, superheater (if any), economizer or air preheater (if any), all stoker drives, forced- and induced-draft fans, and boiler-feed pumps used solely in connection with that boiler during normal operation.

Turbine Unit consists of a turbine, together with the main generators and station power generators and exciters connected to its shaft and auxiliary apparatus used solely in connection with the turbine during normal operation and including under these conditions condensate pump and drive, circulating pump and drive, air removal apparatus, oil circulating and cooling apparatus, generator air-cooling apparatus, main condenser, heaters, exciters and their drive.

Note: This definition conflicts with one given previously for *Generating Unit*, but there appears to be a demand for the definition as given above and it is recommended that the caption of the definition as previously given be changed.

Steam Power Plant consists of groups of equipment and buildings used in converting energy of fuel into electric energy through the medium of steam.

Note: See *Generating Station.*

Boiler Plant is that portion of the station devoted to the generation and transmission of steam. This is intended to include the delivery of ash outside the station building loaded for final disposal and the steam lines up to the turbine throttle.

Note: This definition conflicts with one previously given for *Boiler Room*, in which the coal plant has been included.

Turbine Plant is that portion of the station devoted to the generation of electrical energy beginning with the steam lines at the throttle and ending with the turbine generator leads.

Note: See definition of *Turbine Room.*

[1] An editorial on page 534 discusses this definition for economizer efficiency.

Care of Preheaters*

Certain elements in connection with the use of preheaters must be given careful consideration in their operation. In all types of preheaters there is a deposit of soot or tarry matter on the metallic surfaces which retards heat transference.

The cleaning of preheaters and the number of times a preheater should be cleaned depends largely on the operating conditions of the plant. It also depends upon the grade and character of the coal that is being burned. In some plants, every thirty days, the preheaters are taken off and the accumulation of soot in the tubes blown out with compressed air. This thoroughly removes any foreign particles that have been adhering to the exposed metallic surfaces.

Fluctuating loads on boilers and banking of boilers increases the possibility of hard soot accumulation in preheaters. In some instances serious clogging of the air passages occur, and means must be provided to clean out this hard scale; and operating conditions watched to prevent a recurrence of combinations of moisture in preheaters and soot.

The hard soot accumulation in preheaters is due to moisture in connection with the carbonaceous soot. This moisture comes to the preheater during banked periods when the relative temperature of gases and air creates a condition where dew is formed.

Some coals give off different carbonaceous gases, and these have an effect on the metallic surface of air preheaters. This trouble extends to pitting of tubes and plates. Each set of conditions must be carefully analyzed in order to find out what character of operation and cleaning is necessary to overcome the difficulty.

The design and construction of air ducts leading from air preheaters to the stoker must be given more consideration than the former usual method of cold-air duct design. These ducts must be airtight because the leakage of highly preheated air is more undesirable than the leakage of cold air. All high-temperature air ducts must be insulated. It should be noted that this method consists of a layer of asbestos cement, then the use of blocks of magnesia and an outer covering of canvas.

*Excerpt from paper by Joseph G. Worker before the Iron and Steel Electrical Engineers.

Efficient Small Steam Turbines

The desire for increased plant efficiency has created a need for more efficient small steam turbines for auxiliary use in the smaller power stations, and also certain steam-driven auxiliaries are desired in the larger stations. The demand for higher efficiency is based on the fundamental idea that the heat head in steam should be utilized at the highest possible efficiency within the limits of reasonable cost, and that such utilization will result in an improvement in station economy.

With this in mind, the Prime Movers Committee of the National Electric Light Association addressed communications to several turbine manufacturers with the idea of having them study the possibilities of improvement in such machines and submit recommendations and figures.

The replies from the manufacturers were in general agreement that the smaller-sized turbines for direct connection to the essential auxiliaries could be vastly improved provided there was a real demand. Some felt that stage bleeding of the main turbine and electrically driven auxiliaries had become such common practice as to tend to supplant the steam-driven house turbine and other turbine drives. One manufacturer expressed the opinion that the power-plant engineer has not been sufficiently committed to the use of the small steam turbine in large modern plants to warrant the work that is necessary to the development of even tentative detail designs, although there are some indications that it will be practical to undertake such work in the near future. To take advantage of the possibilities in its application to the driving of power-house auxiliaries, it will be necessary to make full use of reduction gearing of proportions that have proved to be good for continuous service. Another manufacturer expresses the opinion that while more economical auxiliary turbines may be produced if there is a demand for them, the higher economies would be secured through greater complexity, more stages, etc., which cannot but have an effect upon the reliability.

Maintenance of Oil Circuit Breakers*

MODERN oil circuit breakers are designed to withstand, with a good margin of safety, continuous use at or near their rating. A circuit breaker may never have to open the maximum short-circuit possible on a circuit, but it must always be ready to do so if called upon.

In the opening of a short-circuit, the circuit breaker must have sufficient strength to withstand the pressure generated within the tanks by the arcing which vaporizes the oil. Anything that tends to cut down the time of the arcing will increase the ability of the circuit breaker by the same amount. An adequate head of oil must be provided over the point of arcing to insure that the arc gases are cooled sufficiently by their passage through the oil to prevent their ignition after they arise above the surface.

Protecting the Main Contacts

The main contacts should be adequately protected by auxiliary arcing contacts to prevent burning of the main contacts. The contacts that take the arcing should be renewable, so that a minimum amount of time will be consumed in renewals and maintenance. The entire structure should have sufficient strength so that oil and gas will not be expelled in objectionable quantities during the operation. The design should be such that the oil and gas that is expelled will not be ignited outside of the circuit breaker. All the operating details should be designed so that the failure of some small piece will not cause a circuit-breaker failure. Dependable operating mechanism must be provided; they should be simple in design and so made as to give a maximum of service with a minimum amount of attention.

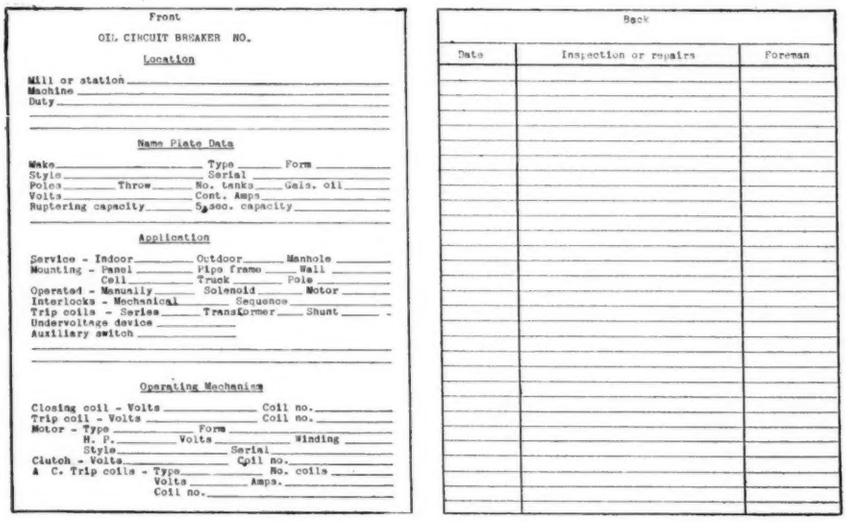
Maintenance is not to be looked upon at all as a mater of "coddling" of weak apparatus. The very best apparatus will perform better, stay on the line longer, and give less trouble if properly maintained. Sometimes equipment known to be on the "ragged edge" can be kept in operation and give good service, until such time as it is possible to replace or repair it, by giving it just a little better than ordinary supervision. In any power distribution system there is generally one or more weak links. Attention paid to these will be more than repaid in continuous performance of the entire equipment.

Making Inspections During the Service Period

A certain amount of inspection of the apparatus may be made while it is in service. It is possible to observe the operation of the circuit breakers and obtain a fair idea of their condition by watching their operation. The external mechanism can be looked over, while keeping at a safe distance, for conditions that might later cause an outage if not corrected. The general temperature of the apparatus can be observed from a safe distance. Any condition that may not be easily corrected while the apparatus is alive should be noted and the correction made at the first opportunity.

Keeping Inspection Records

A record should be kept of all apparatus, giving the date and degree of inspection. A schedule should be made out, giving desirable periods for casual inspection and for thorough inspection. Opportunity should be watched for, so as to make the inspection as closely as possible to schedule. In case it is impossible to get a piece of equipment out of service for inspection for a period of time that greatly exceeds the specified period, then it should be watched more carefully than usual until it receives the desired inspection.



Front

OIL CIRCUIT BREAKER NO.

Location

Mill or station
Machine
Duty

Name Plate Data

Make ____ Type ____ Form ____
Style ____ Serial ____
Poles ____ Throw ____ No. tanks ____ Gals. oil ____
Volts ____ Cont. Amps ____
Rupturing capacity ____ 5 sec. capacity ____

Application

Service - Indoor ____ Outdoor ____ Manhole ____
Mounting - Panel ____ Pipe frame ____ Wall ____
Cell ____ Truck ____ Pole ____
Operated - Manually ____ Solenoid ____ Motor ____
Interlocks - Mechanical ____ Sequence ____
Trip coils - Series ____ Transformer ____ Shunt ____
Undervoltage device ____
Auxiliary switch ____

Operating Mechanism

Closing coil - Volts ____ Coil no. ____
Trip coil - Volts ____ Coil no. ____
Motor - Type ____ Form ____
H. P. ____ Volts ____ Winding ____
Style ____ Serial ____
Clutch - Volts ____ Coil no. ____
A. C. Trip coils - Type ____ No. coils ____
Volts ____ Amps. ____
Coil no. ____

Back

Date	Inspection or repairs	Foreman

Front and back view of circuit-breaker inspection-record card

The figure shows the record of oil-switch inspection kept by one company. The front of this card gives data regarding the manufacture and rating of the apparatus. The back of the card is used to indicate the date and degree of inspection and can also be used to indicate any repairs that may have been made, as well as the date of the repairs. In this way the engineer is able to tell at a glance the condition of the equipment.

An alert operator can make himself valuable in the preventing of outages by watching the apparatus with the idea of continuity of service in mind.

Checking Circuit-Breaker Conditions

It is now becoming standard practice with most operating companies to make a complete check of the condition of a circuit breaker after a given number of operations. One operating company drops the tanks on the circuit breaker, inspects the contacts, checks the condition of the oil, and generally looks over the equipment after every operation of the breaker under short-circuit conditions. The service record of the apparatus of this customer is unusually good. Another operator gives circuit breakers similar attention after three automatic operations. This same operator checks the condition of the equipment every six months, whatever its operating record. This operator also gets good service from his circuit breakers.

Obviously, the degree of maintenance is determined by the severity of the service. It is recommended that the apparatus be looked over after functioning on a short-circuit. The circuit breaker should be checked after five to ten automatic operations, paying particular attention to the quality of the oil, to see that the arcing within the tank has not reduced the insulating quality of the oil to an undesirable degree. The circuit breaker should be looked over after approximately 50 to 100 operations to see that no parts have loosened or became displaced and the quality of the oil should be tested as a matter of routine to insure that everything is in good condition.

The check on this service should show nothing out of order and will probably act mainly to place at rest any uncertainty regarding the condition of the apparatus.

It should be borne in mind that where apparatus is referred to as being inspected after functioning on a short-circuit it is meant that after the breaker has performed its duty cycle in accordance with the A.I.E.E. and N.E.L.A. rulings, that is, 2-O-C-O (Open-Close-Open) at two-minute intervals. Where the breaker operates on overload due to the action of protective relays, the inspection should not be so frequent, an inspection after five or ten operations being considered adequate.

The modern oil circuit breakers to a very large degree are service-tested devices, the apparatus or the equivalent of the apparatus has been in service for a long period of time in a number of plants. Of late, power companies have been co-operating with the manufacturers very closely in making field tests on circuit breakers and switching equipment within the limits of their system capacity. It is through this co-operation that the knowledge of the circuit breaker art is being increased.

*Abstract from a paper, "Selection and Maintenance of Oil Circuit Breakers," by M. J. Wohlgemuth and E. K. Read, presented at the twentieth annual convention of the Association of Iron and Steel Electrical Engineers, held in Philadelphia, Sept. 14 to 19, 1925.

Recent Publications

Dinbuch 11, Keile (Thinbook 11, Keys). By Kurt Hentschel. Published by Beuth-Verlag Gmbh., Berlin (Germany SW 10, 1924; cloth; 6x8 in.; 111 pages; numerous drawings and tables. Price not stated.

This handbook is entirely devoted to the presentation of German standards for keys and keyways in a manner useful to machine designers and draftsmen.

Strength of Materials. By Alfred P. Poorman, Professor of Applied Mechanics, Purdue University. Published by the McGraw-Hill Book Company, Inc., New York. Size, 6x9 in.; 313 pages; 15 tables; 211 illustrations.

This textbook, which is designed for the undergraduate of an engineering school of college grade, covers the theory of stress and deformation in simple tension, compression, shear, and torsion members, in beams of various types, including curved and continuous beams, and in columns and hooks. The book assumes that the reader is familiar with differential and integral calculus, and for such readers it should prove useful, either for the initial study of the subject or for reference. For the practical man who desires to work out numerical solutions of specific problems, a book of this type will be of small assistance, because its information is hidden behind a mathematical form of expression with which he is unfamiliar. The familiar handbooks will be more serviceable for a man of this type, although they fail to give a comprehensive view of the subject, such as is presented by this textbook.

Steam Condensing Plant. By James Sim. Published by D. Van Nostrand Co., New York. Cloth, 6¾ by 9½ in.; 271 pp., 142 illustrations, several tables. Price, $6.50.

This book discloses the performance and design of steam condensers of all types, including surface, low-level jet, high-level jet, ejector and evaporative condensers, and of air ejectors, water-extraction pumps and circulating pumps. The final chapters discuss evaporators for boiler feed makeup, surface feed-water heaters, deaëration plants, with a chapter on feed systems, which gives considerable attention to the closed system of feed-water piping. Several schemes are described and discussed in detail. The author, who is chief designer of the Condenser Department of Messrs. G. & J. Weir, Ltd., of Glasgow, has quite naturally confined himself to British engineering practice. Water quantities are in Imperial gallons, and each chapter closes with a description of commercial types of apparatus, all of British origin. The book is designed to provide students with rational methods for the design of condensing plants, and it should prove very useful for that purpose. The field is covered in some detail, and the theory and design equations for each type of equipment are developed very fully. The thoughtful reader will gain a comprehensive view of condenser practice, and if he be careful to inform himself on the differences between British and American practice, the book should serve well to introduce him to the subject of condenser plant, and the allied apparatus for the provision of boiler-feed water. The practical operating man will find very little in this book which he does not already know.

American Petroleum Supply and Demand: A Report to the Board of Directors of The American Petroleum Institute by a committee of Eleven Members of the Board. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth; 6x9¼ in.; 269 pages. Price, $3.

A summary of this report was given on page 265 of the August 18 issue of *Power*. The report was instigated by the American Petroleum Institute in an effort to assist the work of the President's Federal Oil Conservation Board.

A Graphic Table Combining Logarithms and Anti-Logarithms. By Adrien Lacroix and Charles L. Ragot. Published by the Macmillan Company, New York City, 1925. Cloth, 7x10 in.; 66 pages. Price, $1.40.

This book has immense possibilities of practical usefulness. While the slide rule has largely supplanted logarithmic tables in engineering work, there are still many computations where the ten-inch and even the twenty-inch slide rule is not sufficiently accurate. The engineer must then either have recourse to long-hand computation or to logarithmic tables. The excessive amount of interpolation required in the use of the orthodox logarithmic tables is a positive nuisance and has had much to do with the reluctance of engineers to use them. With these graphical tables any five-place logarithm or number may be read directly without interpolation. Six places can be obtained with the simplest kind of graphical interpolation. The main table of this book is, in effect, a 380-ft. double-slide rule scale cut into short sections, 25 to a page, covering 40 pages. Above the line is a scale of numbers and below is a uniform scale of logarithms. Every possible five-place number or logarithm has a graduation of its own. Estimation of subdivisions is not needed, except where accuracy to six places is necessary.

Versuche Über Strömungsarten, Ventil Widerstand und Ventilbelastung. (Experimental Research to Determine Stream Line Phenomena, Resistance to Flow and Load on Disk Valves). By Dr. E. Schrenk. Published in German by the V.D.I. Verlag G.m.b.H., Berlin, Germany, 1925. Paper, 7½x10¾ in.; 62 pages; 109 illustrations; 19 tabulations. Price, 10 gold marks.

In research making extensive use of photography, the author has studied the stream-line phenomena that occur in flat- and bevel-seat disk valves, cup-shaped valves, and valves equipped with diffusers. Special testing apparatus made it possible to measure the resistance to the flow and the pressure on top of the valves under a great variety of conditions. The results are shown graphically by curves and in tabular form, which will be of practical value to the designers of equipment using disk valves.

Standards of the Hydraulic Society. Third edition. This pamphlet contains besides the information embraced in the earlier editions, new and valuable data, such as a standard classification of pumps; standard nomenclature and definitions pertaining to the industry; standard dimensions for cast - iron flanges and cast-iron flanged reducers for 125 lb. and 250 lb. steam pressures as adopted by the A. S. M. E.; and a very complete list of chemicals and other special liquids, specifying the materials recommended in the construction of pumps for handling these special liquids. Copies of the booklet may be obtained from any pump manufacturer who is a member of The Hydraulic Society, or upon application to C. H. Rohrbach, secretary, 90 West Street, New York.

Bituminous Coal as Generator Fuel for Large Water-Gas Sets with Waste Heat Boilers, by William A. Dunkley, Bureau of Mines, Government Printing Office, Washington, D. C. This paper, Technical Paper No. 335, represents work done under a cooperative agreement among the Bureau of Mines, the State Geological Survey Division of the State of Illinois and the Engineering Experiment Station of the University of Illinois.

The Analysis of Fuel Gas, a forty-page booklet prepared by S. W. Parr and F. E. Vandaveer of the University of Illinois, is a concise summary of the various methods available for determining the constituents of fuel gas. Two types of modified Orsat for complete gas analysis are described. This circular (No. 12) may be obtained for 20c. from the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Test Code for Feedwater Heaters— This is one of the A.S.M.E. Power Test Codes which was printed in tentative form in 1922 and was approved in its finally revised form in March, 1924. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Price 30 cents to members and 35 cents to non-members.

Thumb Nail Analysis of the Electric Light and Power Industry. Published by The Beeler Organization, 52 Vanderbilt Ave., New York City. Paper; Price $1. This pamphlet gives in concise form the statistics of the electric light and power industry.

The Transactions of the First World Power Conference, a review of which was published in *Power*, July 28, page 154, can also be purchased from D. Van Nostrand Co., 8 Warren St., New York City, for $70. This includes the Index volume.

News in the Field of Power

New Application for Water on Pit River

The Mt. Shasta Power Corp., pursuant to its preliminary permit of May 5, 1923, has applied for license covering Pit No. 4 site on Pit River, near Reading, Calif. The power is to be sold to the Pacific Gas & Electric Co. The development will make available 56,880 hp. of primary power. It is proposed to install three 40,000-hp. generators.

New Diesel Engine Succeeds in Tests

A test of the new 1,000-hp.-Diesel electric locomotive constructed by the Baldwin Locomotive Works was made on Sept. 30 at Reading, Pa. The test was highly successful.

The locomotive is capable of carrying enough oil to last during the run from Philadelphia to Chicago. This particular type, according to engineers, is expected to save 75 per cent of the fuel cost as compared with modern steam locomotives and is the result of ten years of experimenting.

In appearance it resembles an electric more than a steam locomotive, as it does not have a smokestack and only a small exhaust pipe from which it exudes a thin white vapor.

The locomotive will be on exhibition at the American Electric Railway Association convention at Atlantic City next week. Afterward it will be given trials by the Pennsylvania Railroad and the Long Island. Later it will be sent to several Western railroads for trial runs.

Georgia Power Co. Hit Badly by Drought

Power companies in Georgia have been hard hit by one of the most serious droughts ever experienced, and at the present time are operating under severe handicaps.

The reservoirs of the Georgia Railway & Power Co., which cover more than 50 square miles, are practically dry, and generate barely enough electricity to operate the street-railway system and office-building elevators in Atlanta. During normal times this company sells electricity to Rome, Athens, Buford, Gainesville, Marietta, College Park, Decatur, East Point, and many other smaller towns in north Georgia.

Manufacturing plants that employ electrical power, are operating only at night on power generated by a turbine only recently placed in operation for the Alabama Power Co. at Muscle Shoals, Ala. This power is transmitted to Atlanta over an emergency line of the Georgia Railway & Power Co. This method enables the regular reservoirs of the power company to store up water over night.

By special permission of the Georgia Public Service Commission, the company has been permitted to cut down the street-car service to a minimum, thus enabling the company to conserve power for other utilities which are classed as necessities. Officials of the company state it is enabling them to conserve considerable power.

Augusta street-car service has been reduced to one car an hour on each line. Secondary service has been cut off in a number of cases, and power companies are buying steam power from other concerns and supplying customers at a loss.

Detroit in Earnest About Smoke Abatement

John W. Smith, Mayor of Detroit, has recently signed the anti-smoke ordinance recently passed by the city council. The ordinance becomes effective thirty days after its signature by the Mayor.

Provisions of the ordinance call for a smoke-abatement division of the Department of Buildings and Safety Engineering. This division will have complete charge of investigations of smoke-nuisance conditions in Detroit and the enforcement of the ordinance. Appointment of a chief engineer and several assistants will be made as soon as the ordinance becomes effective. They will supervise work among engineers, boiler operators and firemen. The Ringleman smoke charts distributed by the Bureau of Mines is the standard of comparison to be used in determining the density of the smoke.

Violators of the smoke ordinance will face fines ranging from $25 to $100 and a 90-day sentence to the Detroit House of Correction.

Tennessee River Power Wanted by Three Groups

According to announcements in the press by Col. Hugh L. Cooper, three groups of power companies and industrial concerns are planning to bid for the right to develop the entire Tennessee River on which Muscle Shoals is situated, for the purpose of constructing and operating what would be the largest hydro-electric system in the world. Colonel Cooper says that he represents one of the groups. These plans would double the industrial strength of the South and produce one-fifth of the hydro power of the country. Colonel Cooper would not give the composition of the groups, but said that two were composed of electric power interests and the third of men interested in industrial chemistry.

"There has been $50,000,000 spent on Muscle Shoals by the government. We would produce to reimburse the Treasury for that amount over a period of fifty years and pay 4 per cent on the government's investment during that time. Then we would develop the balance of the river power under the supervision of the Federal Power Commission. The government has made a survey of the storage possibilities of the Tennessee River and has estimated that its low flow might be doubled by proper storage. To develop the entire river up and down would probably require the expenditure of $150,000,000 more. That would give a production of 4,000,000,000 kw., one-fifth of the total hydro-electric production of the country. There is 700,000 hp. now in the factories of the South, and the 'new' Tennessee River would give about 1,250,000 hp. additional.

No Tennessee River Licenses Considered Before Nov. 15

Assurances have been given the Muscle Shoals Commission by Chairman Davis of the Federal Power Commission that no applications for rights on the upper Tennessee River will be granted pending the formulation of the Commission's report, which must be ready Nov. 15. Secretary Davis gave this assurance when advised by the staff of the Federal Power Commission that no one of the eleven applications on the upper Tennessee would be laid before the Commission, in the ordinary course, prior to Nov. 15.

The only one of the eleven applications that is in final form is that of the Hiawasse River Power Co. The death of the president of that corporation, however, has given rise to uncertainties that would have precluded the consideration of that application had there been no request from the Chairman of the Muscle Shoals Commission.

Big New England Power Merger Announced

The rumor of a union of companies in New York and New England to form the New England Power Corp., *Power*, Sept. 29, page 508, has been confirmed. The New England Company is to be the holding company. This union will include The Power Corp. of New York, Stone & Webster, Inc., International Paper Co. and the recently formed New England Power Corp.

The interests to be associated with the company are identified with the electric light and power systems covering a large part of Massachusetts, Rhode Island, Vermont and northern New York. They own over a million horsepower of developed and undeveloped water power, beside some of the largest and most efficient steam plants in the Eastern States.

Engineers of Wilson Dam Give Their Opinion Regarding Relative Value of Power Generated There

Hugh L. Cooper, Designer and Supervisor, Gives Figures on Power and Costs—Major M. C. Tyler, Army District Engineer, Tells of What the Dam Is Worth for Power and for Nitrates

THE ENGINEERS responsible for Wilson Dam of the Muscle Shoals development have made public statements concerning their opinion as to the disposition of this great property.

Col. Hugh L. Cooper, designing and supervising engineer of Wilson Dam, has the following after a review of the beginnings of the undertaking, to say:

"The design and construction of the works was begun in 1918, since which date, with various interruptions, due to lack of government appropriations, the work has progressed until today the first installation of eight units, with a generating capacity of 260,000 hp., is nearly ready for service. The ultimate station will contain eighteen units, with a generating capacity around 600,000 hp. When the station is completed, around 2,500,000,000 kw.-hr. of energy will be available for consumption in the South, representing a saving of about 3,700,000 tons of coal per annum.

"The work, when finally completed, will have cost around $52,000,000, and if we can keep corporation greed and politics out of the disposition of this great enterprise, Muscle Shoals and the Tennessee River can be made the keystone of a vast superpower system that will serve around twelve millions of people in six states of the South with benefits that can come to them in no other way.

"The Tennessee River has not in the past occupied any particularly important place in the public eye as a power and navigation possibility, but if sound engineering can be carried on in a sane manner, the Tennessee River can be rebuilt with wide benefits to navigation and with power production equal to more than one-fifth of all of the hydro-electric power that is now used in the United States, Niagara Falls included.

"The Muscle Shoals dam, as it stands today, is the largest block of masonry yet built as a dam anywhere in the world, being larger than the Nile Dam at Assouan."

What is Wilson Dam Worth?

Major M. C. Tyler, Corps of Engineers, U. S. Army District Engineer, Wilson Dam, has the following to say in regard to worth of the dam:

"In any study of the problem certain facts stand out in bold relief:

"The public-utility companies in the Southeast are interconnected from Virginia to Mississippi. This makes a wide use, especially in emergencies, of Muscle Shoals power.

"The rapid growth of the demand for power in the Southeast in diversified industry and agriculture insures the absorption within five years of the entire primary power capacity of Wilson Dam and the steam plant, at remunerative rates, if the power from those plants is distributed through the interconnected systems of the public utilities.

"Northern Alabama, western Tennessee and Mississippi must look to the lower Tennessee River for such increase in hydro power as those sections are to receive, viz., to Wilson Dam now built, and to possible new developments of about one-half the head at Colbert Shoals, Dam No. 3 and Guntersville.

"The government owns two war nitrate plants at Muscle Shoals, and there is strong sentiment that they should be operated for the production of fertilizer by means of power from the government-owned power plants.

"Wilson Dam is a combined navigation and power development and in round numbers, its cost without step-up transformer station, will be $46,000,000. Probably $9,600,000 would be a fair estimate of the value of the navigation benefits, leaving $36,400,000 as the amount invested for power purposes.

"If the low-water capacity of Wilson Dam (about 66,000 kw.) is devoted to the operation of the nitrate plants or other strictly local market, the annual load factor will depend upon local conditions, marketing conditions of the single large industry served, breakdowns in the single industry and the like. Probably under these conditions Wilson Dam would not produce more than 400,000,000 kw.-hr. per annum, and a comparison of the cost of production including interest, sinking fund, maintenance and operation, with the corresponding items for a modern steam plant of equal capacity, would fix the value of Wilson Dam at about $13,600,000, or about one-third of what is invested in it for power purposes.

"On the other hand, if Wilson Dam is operated in connection with the government-owned steam plant (70,500-kva. capacity) and the power is distributed through the interconnected system of the public utilities of the Southeastern states, it seems certain that within five years the two plants can dispose of 860,000,000 kw.-hr. of primary power at a cost around 3.4 mills per kw.-hr., including interest, sinking fund, maintenance and operation on both plants.

"A careful estimate of the value to the public of Wilson Dam and the existing steam station compared with the value of a modern steam station of capacity equal to the two plants on the same basis of interest on investment and sinking funds and including maintenance and operating costs, shows that if Wilson Dam is operated in connection with the steam station at Nitrate Plant No. 2, supplying energy for diversified industry and agriculture through the public-utility transmission net, Wilson Dam is worth about $61,000,000 or about 68 per cent more than has been invested in it for power purposes, or about 4½ times as much as it is worth if operated solely for the production of nitrates.

"This comparison takes no account of the possibility of the sale of secondary power, for which there is little prospect of any market except through the public-utility systems as and when new steam stations are built."

Junior Engineer Needed by the Government

The United States Civil Service Commission is announcing an open competitive examination for junior engineer, applications for which must be in before Nov. 14. Practically all branches of engineering are included. The entrance salaries begin at $1,860. Full information can be secured from the Commission at Washington, D. C., or at the post office or custom house of any city.

Carbon Brush Simplification Under Way

As a result of requests which have been received by the Division of Simplified Practice, Department of Commerce, for co-operation in steps to reduce the number of sizes of carbon brushes used in electrical equipment, a preliminary meeting of manufacturers of carbon brushes was held on Sept. 30 in the offices of the Associated Manufacturers of Electrical Supplies, 30 East 42nd St., New York City.

The information received by the Division indicated that in the automotive field alone there is a choice of some 2,400 sizes of commutator brushes, and that the car owner must pay the cost of this wide variety. Other information indicates that fully as great a variation of sizes exists in the marine field, and that virtually every type of electric motor has its own special size of brushes. So serious is this condition on shipboard that it is necessary to carry a complete line of spare brushes for every commutation and slip-ring machine installed in order to avoid expensive delays in foreign ports.

The manufacture of such a variety is made costly, it is declared in some quarters, by the fact of the investment in finished product and the cost of constant machine changes.

The problem has been taken up by the carbon section of the Associated Manufacturers of Electrical Supplies, and a number of outside interests have been asked to take part in the preliminary consideration. Among those who were represented were: The National Carbon Co., Stackpole Carbon Co., Speer Carbon Co., and Corliss Carbon Co., who are members of the carbon section; the General Electric Co.; U. S. Graphite Co., of Saginaw, Mich.; Pure Carbon Co., of Wellsville, N. Y.; Ohio Carbon Co., of Cleveland, Ohio, and Superior Carbon Products Co., Inc., of Poughkeepsie, N. Y. The Division of Simplified Practice was represented by Edwin W. Ely.

The conference it is expected will result in steps leading to a survey of the conditions existing, both as to variety and demand, in the many fields in which carbon brushes are required.

Coal Situation Discussed By Well-Known Men

At a meeting held by the Industrial Relations Department of the National Civic Federation, held at the Merchants' Association rooms in the Woolworth Bldg., New York City, on Sept. 29, various angles of the coal situation were taken up by notable speakers. John Hays Hammond, former chairman of the President's Coal Commission, read a lengthy paper covering the recommendations made by the Commission at the conclusion of its study in 1923. He said among other things:

"I do not think that the present strike is justified, for I believe that the grievances of either side could be redressed without adding to the cost of production by following the recommendations of the Coal Commission specifically made to operators and miners, and the substitution of an honest co-operative spirit between the operators and the union for the belligerent spirit now prevailing. Certain it is that the demand for the increase of $1 a day for company men with a flat increase of 10 per cent for tonnage miners and the check-off is unreasonable."

Discussing royalties as a factor in cost, Mr. Hammond said that about one-third of the output of coal is mined under leases where the operators pay the land owner a royalty. These royalties have increased greatly during the last ten years and range from 12 cents to $1.50 and more a ton. He said that the royalties of the Girard estate lease averaged, in 1921, $1.27 per ton "on all coal mined, amounting to 3,000,000 tons, a high rate on unearned increment."

Mr. Hammond said that an extra session of the Pennsylvania Legislature could repeal the state law which requires a man to serve two years as a contract miner's helper before he is able to qualify as a certified miner.

"The effect of this law, together with the complete unionization of the mines, gives the United Mine Workers virtually a monopoly of miners' labor."

Mr. Adam Shortt, of Ottawa, former chairman of the Canadian Mediation Board, gave some useful examples of how they settled industrial disputes of the same general nature as the present coal strike without resort to legal methods while he was chairman of this board.

Matthew Woll, vice-president of the American Federation of Labor, protested against adoption of the Coal Commission recommendations which he interpreted as unwarranted governmental interference with the coal industry. Mr. Woll asserted that the American labor movement was opposed to every form of compulsory arbitration, including the establishment of industrial courts, and that it favored the idea of conciliation and voluntary arbitration. The government could help, he said, not by regulating the industry, because there was the danger that industrial problems might be referred to political sources for settlement. Mr. Woll argued that in the mining industry as well as in other industries the greatest evil was the anti-trust laws. His solution for industrial ills was to permit employers and employees to organize and seek to settle the ills of their respective industries. Less legislation and more voluntary action was his advice.

Dr. Edward Devine, who was a member of the Coal Commission, defended the recommendations of the commission and criticized what he termed the vice of the uniform wage increase demanded by the miners. For the miners now to obtain a flat wage increase would simply mean that the present inequality of rates would continue. He said that the 10 per cent increase would give the contract miners more than they were entitled to, while other workers were perhaps entitled to higher increases than the contract miners.

Arkansas River Regulation Proposed

A daring river regulation proposal, on which four Western States are spending effort and money, was discussed at a meeting of state water commissioners Aug. 26 and 27 at Amarillo, Tex., according to the *Engineering News-Record*. Regulation and utilization for beneficial purposes of the waters of the Arkansas and its tributaries was the subject of the meeting. The general plan considered would provide storage of the flood run-off in reservoirs, lakes and ponds, the stored water to serve for irrigation in the more western plains region, while in the central portion (more particularly Oklahoma) it would be utilized for domestic water supply, power development and the establishment of great fish and game preserves. Farther east in Arkansas holding back the floods will improve navigation and permit reclamation of 4,000,000 acres of overflowed lands. Regulation of the floods will have a beneficial effect on the lower Mississippi.

It is planned that through the adoption of an interstate treaty, such as has been proposed for the Colorado River, the states (through conservation districts) and the United States shall co-operate in the complete regulation of the stream so far as it is practicable. Further, that necessary funds shall be raised by conservation districts to be created, and that assessments be made on the basis of benefits received.

At the Amarillo meeting New Mexico was represented by R. J. Freeland and J. A. Dykes, commissioners, of Tucumcari; Texas by A. S. Stinnett, commissioner of Amarillo; Kansas by George S. Knapp, state irrigation commissioner, Topeka; and Oklahoma by E. E. Blake and W. A. Strong, members of the Irrigation, Drainage & Reclamation Commission created at the last session of the state legislature. These men were officially appointed by the respective governors of the states named. A. Lincoln Fellows, irrigation engineer of the Division of Agricultural Engineering, U. S. Department of Agriculture, advised with the members and commissioners present. Mr. Blake, chairman of the newly founded Oklahoma commission, is devoting his entire time to the subject.

Swansea to Specialize on Combustion

The demand for combustion economy engineers has sprung up rather suddenly in England, due to the high cost of fuel which occurred during the World War and which became still more acute in the artificial boom years that followed.

To meet this need the University College of Swansea, Singleton Park, Swansea, England, a rather young university college, having been founded in 1920, is making an attempt to focus the attention of its engineering department on the training of combustion engineers. To further its efforts some of the prominent engineering and industrial firms have donated much of the necessary equipment for a very complete power plant. Other donations will probably be received to perfect such an important adjunct as a power plant for a course in modern practice.

The Kachlet dam, which is under construction in the Danube River, will develop 42,600 hp., it is announced in the press. It will be the most productive of power of all the stations in the course of the new ships canal and will supply the whole surrounding country with current.

Obituary

Frederick Fort Wormer, president of the Wright-Austin Co., manufacturer of steam specialties, Detroit, Mich., died at Hollywood, Calif., on September first. Mr. Wormer was one of the founders of the Wright-Austin business, having recently completed his thirtieth year of active and continuous service in the development of the business.

Personal Mention

Richard A. Trotter has accepted a position as instructor in steam engineering at the University of Wisconsin.

Luther B. McMillan has been appointed chief engineer of Johns-Manville, Inc., in the department of general engineering and research.

Ray C. Burrus, who has been in the engineering division of the Fulton Iron Works Co., St. Louis, Mo.. has resigned to accept a position with the Foos Gas Engine Co. at Springfield, Ohio.

Rear Admiral Robison, for the past four years head of engineering, Navy Dept., has been automatically relieved from this position, having finished his four-year term. His successor has not yet been announced.

H. J. S. Mackay, managing director of the Stirling Boiler Co., Ltd., London, and **Charles Knight**, also from the London office of this firm, recently paid a visit to the Babcock & Wilcox Company Works at Bayonne, N. J.

Fritz Meyer and **E. Baumann**, representatives of Sulzer Brothers, Winterthur, Switzerland, arrived on Sept. 23, for a visit to America to study oil

engines and high-pressure steam. They intend to spend two months in this country.

Elwood M. Manter has left the Brooklyn Edison Co. to become instructor in thermodynamics and heat engineering at Lafayette College, Easton, Pa.

George A. Guerdan has resigned as assistant engineer at the Waterside plant of the New York Edison Co., to become instructor in machine design at Stevens Institute, Hoboken, N. J.

Gustaf A. Gaffert, formerly an instructor in mechanical engineering at Worcester Polytechnic Institute, has accepted a similar position at the University of Illinois at Urbana.

George W. Thunen, of the San Joaquin Light & Power Corp., has been appointed efficiency engineer of the Bakersfield and Midway steam plants of this company. He will make his headquarters at Bakersfield, Calif.

Society Affairs

The Metropolitan Section of the A.S.M.E. will have its Fall dinner and smoker at the Hotel Astor, Nov. 5 at seven in the evening.

The Technical League of the Employees Mutual Benefit Association of the Milwaukee Electric Railway & Light Co. will hold a power-plant night on Oct. 8 at the Public Service Bldg., Milwaukee, Wis.

The St. Paul Section of the A.S.M.E. will hear E. K. Culbertson, Robinson Cary & Sands Co., St. Paul, speak on "Evolution and Development of the Small Power Plant in the Northwest," at its regular monthly luncheon meeting on Oct. 13.

The Pittsburgh Section of the A.S.M.E. will meet with the Mechanical Section of the Engineers' Society of Western Pennsylvania at the William Penn Hotel, on Oct. 7. "Fundamentals in the Conditioning of Boiler Waters," by **Dr. R. E. Hall**, physical chemist, Pittsburgh Experiment Station, U. S. Bureau of Mines, will be the attraction.

The Chicago Section of the A. S. M. E. on Sept. 23 at the City Club, held its first meeting of the season, a get-together session with buffet dinner, featured by entertainment. Routine business, such as committee appointments and other matters, was conducted with dispatch, and considerable time given to H. V. Coes, who in the absence of the president-elect, W. L. Abbott, talked on the aims and objects of the society, with special references to past accomplishments, the need for research and the consideration now being given to the co-ordination of the work of the various professional divisions.

Business Notes

The Linde Air Products Co., manufacturer of oxygen for welding and cutting, 30 East 42nd St., New York City, announces that its district sales office at Seattle, Wash., is now located at 619 South Second Ave., and that O. H. Davenport is district manager in charge.

The Conveyors Corp. of America, 326 West Madison St., Chicago, Ill., announces the appointment of Rowland Burns, 39 Cortlandt St., New York City, as district engineer for the corporation.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engnieering Building, New York City, Feb. 8-12, 1926.

American Marine Exposition. Peter A. Sensenrg, 15 Park Row, New York City. Exposition to be held in the 212th Anti-Aircraft Armory, 62nd St. and Columbus Ave., New York City, Nov. 9-14.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Atlantic City, Nov. 23-25.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Convention at the Engineering Building, 29 West 39th St., New York City, Nov. 12-13.

The General Electric Co., Schenectady, N. Y., has just announced plans for the immediate erection of a warehouse and office building to be located at Santa Fe Ave. and Thirty-second St., Los Angeles.

Trade Catalogs

Ohmmeters, Record—Chas. Cory & Sons, Inc., 183 Varick St., New York City. Catalog 104-29-B describes the audible and visible signals, featuring the turbine order system. The catalog is well illustrated with pictures of types of instruments and wiring diagrams.

Fuel-Oil Handling Equipment — The Ames Pump & Machinery Corp., 90 West St., New York City. Specification No. 102, "Ames Unit System," gives specifications for the system, which consists of duplex oil pumps, multi-pass steel-shell fuel-oil heaters, together with appurtenances all proportioned for specified conditions of service, completely assembled, ready for service connections. The bulletin will be furnished upon application.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Sept. 28 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.39
Clearfield	Boston	1.75@ 2.10
Somerset	Boston	1.80@ 2.20
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	2.00@ 2.15
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$3.00
Buckwheat No. 1	Philadelphia	2.50
Birdseye	New York	1.60

FUEL OIL

New York—Oct. 1, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal., 36@40 deg. 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Sept. 30, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32 @36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—Sept. 24, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Sept. 26, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Sept. 23, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Sept. 28, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Sept. 29, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅜c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—Sept. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl.; 24@26 deg., $1.10 per bbl.; 30@32 deg., $1.25.

New Plant Construction

Ark., Conway—Municipal Light & Power Co., E. V. Leverett, Mgr., is in the market for 240 and 300 hp. oil burning engines and generators.

Ark., Siloam Springs—J. R. Abercrombie, Chn. Water and Light Bd., plans to purchase and install an engine and dynamo. Estimated cost $9,000.

Calif., Los Angeles — Channel Building Corporation, 1030 Bank of Italy Bldg., has had plans prepared for the construction of a 10 story office building including steam heating system and elevators at First and Frost Sts. Estimated cost $600,000. J. M. Haenke, 412 Rives-Strong Bldg., is architect.

Calif., Redwood City—San Mateo County, G. A. Kneese, county surveyor, is having plans prepared for improvements to waterworks system at the county farm including a 50,000 gal. tank, electric pump, pumphouse, etc.

Calif., San Diego—J. D. Spreckles, 511 South Spring St., Los Angeles, awarded contract for the construction of a 13 story bank, store and office building on Broadway, here, to Edwards, Wildey & Dixon, Edwards, Wildey & Dixon Bldg., Los Angeles. Estimated cost $934,000. Steam heating system and elevators will be installed.

Fla., Bradenton—West Florida Ice & Ice Cream Corporation, G. V. Denny, Gen. Mgr., plans the construction of a 50 ton ice and cold storage plant.

Fla., Jacksonville—Milldale Ice Co., 1010 Bay St., plans the construction of an ice plant. Estimated cost $35,000. C. T. Baker, 526 Candler Bldg., Atlanta, Ga., is engineer. $75,000 worth of equipment including freezing tanks, condensors, etc., will be purchased.

Fla., Lake Worth — The Palm Lake Corporation is receiving bids for a 100,000 gal. elevated tank, pump, deep well, water mains, etc. G. Kingsley, is chief engineer.

Ill., Rockford—Thayer Action Co., 18th Ave. and 10th St., plans the installation of a 500 hp. Skinner uniflow engine direct connected to a 520 General Electric 440 v. generator, auxiliary equipment, etc., to increase capacity of power plant. Estimated cost $100,000.

La., Shreveport—Wittenberg, Deloney & Watts, South Trust Bldg., Little Rock, Ark., plans the construction of a 7 story apartment at Elizabeth Place and Margaret St., here. Estimated cost $500,000. T. P. Florida, Hall Bldg., Little Rock, Ark. and E. K. Tigrett, 80 Madison Ave., Memphis, Tenn., are architects.

La., Thibodaux — City plans an election Oct. 6th to vote $60,000 bonds for improvements to waterworks including pumping equipment, mains, etc., $25,000 bonds for improvements to municipal light and power plant including engine, dynamos, etc. and $30,000 bonds for sewers including pumping plant, equipment, etc.

Mass., Brookline (Boston P. O.)—Pelham Hall, Inc., c/o A. H. Bowditch, 44 Bromfield St., Boston, Archt., awarded contract for the construction of an 8 story apartment at Beacon and Pleasant St., to M. W. Ryan, 763 Massachusetts Ave., Cambridge. Estimated cost $1,000,000.

Mass., Sommerville (Boston P. O.)—Ford Motor Co., Highland Park, Mich., plans the construction of a pumping station on the Mystic River here. Private plans.

Mich., Birmingham—H. E. Lawler, Clk., will receive bids until Oct. 12th for furnishing and installing a 1,000 g.p.m. motor driven pump against a total head of 275 ft. deep well turbine type, 300,000 gal. capacity, elevated steel tank, etc.

Mich., Detroit—W. O. Briggs, 11631 Mack Ave., is having plans prepared for the construction of a 5 story apartment including steam heating system, boiler, etc. on Covington Drive. Estimated cost $500,000. A. Kahn, 1000 Marquette Bldg., is architect.

Mich., Detroit — Hudson Motor Car Co., 12601 Jefferson Ave., is receiving bids until October 9th for the construction of a power house including boiler, pumps, elevator and coal bunker, 1800 c.f.m. air compressor, etc. for plant at Gratiot Ave. A. Kahn, 1000 Marquette Bldg., is architect.

Mich., Detroit — H. Kiefer Hospital, Hamilton and Blaine Aves., plans the construction of a power house. Estimated cost $200,000. A. Kahn, 1000 Marquette Bldg., is architect.

Mich., Detroit—Public Lighting Comn., East Atwater St., awarded contract for the construction of the superstructure for power plant on Morrell St., to W. E. Wood Co., 1805 Ford Bldg., $1,534,800.

Mich., Grand Rapids — Grand Rapids Trust Co., Monroe St., will receive bids until October 9th for the construction of a 12 story office building including steam heating system, boilers, etc. at Monroe St. and Ionia Ave. Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, are architects.

Miss., Greenville—King's Daughters is having plans prepared for the construction of hospital including a power house. Estimated cost $200,000. W. F. Schulz, Chamber of Commerce Bldg., Memphis, Tenn., is architect.

Mo., Buffalo — City plans an election October 5th to vote $45,000 bonds for the construction of a waterworks system including pumping equipment, tank on tower, etc. Russell & Axon, 412 McDaniel Bldg., Springfield, Mo., are engineers.

Mo., Kansas City—Missouri Hydro Electric Power Co., Land Bank Bldg., is making preliminary surveys for the construction of a power plant and dam across Eleven Point River in Oregon and Howell counties. Private plans.

Mo., Richland—Ozark Pipe Line Corporation, plans the construction of a pumping station and installation of 3 engines, to operate ice plant and light system. Estimated cost $140,000.

Mo., St. Louis—St. Louis Maternity Hospital, 4518 Washington Blvd., will soon receive bids for the construction of an 8 story hospital on Kings Highway. Estimated cost $500,000. LeBeaume & Klein, Compton Bldg., are architects.

Mo., St. Louis—Saum Architects, 713A Chestnut St., plans the construction of a 9-story apartment at Grand and Castleman Aves. Estimated cost $1,000,000. Private plans.

Neb., Lincoln—Lancaster Hotel Co., c/o T. M. Murphy, 409 Sharp Bldg., Kansas City, Mo., awarded contract for the construction of an 11 story hotel at 13th and M Sts., here, to Collins Bros., 1600 Grand Ave., Kansas City, Mo. Estimated cost $1,500,000.

N. Y., New York—Courtland Bishop Corporation, J. A. Dowd, V. Pres., 14 Wall St., awarded contract for the construction of a 15 story apartment at 6th Ave. and 55th St. to Cauldwell-Wingate Co., 381 4th Ave. Estimated cost $1,500,000.

N. Y., New York—Bryant Park, Inc., W. J. Salmon, Pres., 17 West 42nd St., is having plans prepared for the construction of a 15 story addition to office building at 6th Ave. and 42nd St. Estimated cost $1,500,000. York & Sawyer, 100 East 42nd St., are architects. C. R. Place, 70 East 45th St., is engineer.

N. Y., New York—New York Central Railroad Co., C. S. White, Purch. Agt., 466 Lexington Ave., will receive bids until Oct. 9th for the installation of a 500 kw. d.c. turbo-generator set with generator and feeder switchboard panels in power station, Cont. 25. G. G. Kittredge, is chief engineer.

N. Y., New York—Savoy Hotel, L. A. Boomer, Pres., 767 5th Ave., awarded contract for the construction of a 37 story hotel at 5th Ave. and 59th St., to Fuller Construction Co., 175 5th Ave. Estimated cost $17,000,000.

N. Y., New York—W. A. R. Realty Co., c/o E. Roth, 119 West 40th St., awarded contract for the construction of a 20 story office building at 5 East 57th St., to Dwight P. Robinson & Co., Inc., 125 East 46th St.

O., Barberton—Columbia Chemical Co., plans the construction of a power plant. Estimated cost $200,000.

O., Cleveland—Durable Lead Coating & Tinning Co., O. Vojgl, Pres., 4415 Czar Ave., is in the market for 12 to 15 hp. gas engine.

O., Columbus—E. A. Prentice Lumber Co., E. A. Prentice, Gen. Mgr., 441 North Park St., is in the market for fifteen 3 to 20 hp. motors.

O., Defiance—City plans an election Nov. 3 to vote $425,000 bonds for the construction of a municipal electric light plant. Engineer not selected.

Okla., Bartleville—Phillips Petroleum Co., has had plans prepared for the construction of a 7 story store and office building. Estimated cost $500,000. Keene & Simpson, Land Bank Bldg., Kansas City, Mo., are architects.

Okla., Opelika—City plans an election October 14th to vote $225,000 bonds for improvements to waterworks system including pumping plant, mains, etc.

Pa., Allentown—J. K. Bowen, 9th and Hamilton Sts., plans the construction of a 10 story hotel. Estimated cost $1,400,000. Thomas, Martin & Kirkpatrick, 220 South 16th St., Philadelphia, are architects. Day & Zimmermann, 16th and Walnut Sts., Philadelphia, are construction managers.

Pa., Philadelphia — Apartment Homes Inc., Stock Exchange Bldg., will soon award contract for the construction of a 5 story apartment at 4111 Walnut St. Estimated cost $700,000. Watson Co., 15 Park Row, New York, N. Y., is architect.

Pa., Philadelphia—Dept. of Public Works, Bureau of Water, will receive bids until Oct. 13th for Cont. 775; construction of Oak Lane pumping station at Chelton Ave. and 5th St., Cont. 778, intake conduit at Torresdale pumping station, Cont. 776 furnishing and installing 3 motor driven centrifugal pumps, etc., at Oak Lane booster station.

S. D. Midland—City plans the construction of a waterworks system including pumping equipment, mains, etc. Estimated cost $15,000. Engineer not announced.

Tenn., Chattanooga—Read House, S. R. Read, Pres., 9th and Broad Sts., awarded contract for the construction of a 328-room addition to hotel to Fuller Construction Co., 175 5th Ave., New York, N. Y. Architects estimate $1,250,000.

Tenn., Nashville—Noel & Co. Ice & Cold Storage Co., 607 10th Ave., N., awarded contract for the construction of an 8 story ice and cold storage plant, 2nd unit, on 10th Ave. S., to Gould Construction Co., Independent Life Bldg. Estimated cost $500,000.

Tex., Asherton—City is having preliminary plans prepared for the construction of a waterworks system including pumping equipment, mains, etc.; also plans the construction of a municipal electric light plant. Estimated cost $40,000 and $30,000 respectively. R. W. Taylor, mayor.

Tex., Gonzales—Midwest Utilities Co., is having preliminary plans prepared for improvements to waterworks system including, pumping equipment, mains, etc. Estimated cost $35,000. Company engineers in charge.

Tex., Huntsville—City plans an election soon to vote $40,000 bonds for improvements to waterworks system including 150,000 gal. reservoir, new motor and compressor, mains, etc.

Tex., Victoria—Victoria Electric & Ice Co., S. M. Udden, 1020 Frost Bldg., San Antonio, will soon award contract for the construction of a 25 ton capacity ice plant here. Estimated cost $40,000. J. Marriott, Frost Bldg., San Antonio, is architect and engineer.

Tex., Welasco—Watson & Stevenson, has had plans prepared for the construction of a 25 ton capacity ice plant. Estimated cost $40,000. Private plans. Machinery will be purchased.

Wis., Fond du Lac—Winnebago Cheese Co., 233 West Division St., awarded contract for the construction of a cold storage plant to Immel Construction Co., Dana Bldg. Estimated cost $40,000. Refrigeration machinery will be installed.

Wis., Kaukauna—Green Bay & Mississippi Canal Co., Insurance Bldg., Appleton, awarded contract for the construction of a hydro-electric power house here to C. R. Meyer & Sons Co., 50 State St., Oshkosh. generator and waterwheels to Allis-Chalmers Mfg. Co., West Allis, switchboard and transformers to General Electric Co., 425 East Water St., Milwaukee.